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TM 9-4931-700-14/1

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL:

AC VOLTAGE STANDARD, HEWLETT-PACKARD MODEL 745A-C90

CALTRONIX INC.
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Rochester, NY 14623
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HEADQUARTERS, DEPARTMENT OF THE ARMY
OCTOBER 1971

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. Since the manual was not prepared in accordance with military specifications, the format has not been structured to consider level of maintenance nor to include a formal section on depot overhaul standards.

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OPERATING AND SERVICE MANUAL

HP Part No. 00745-90025

AC CALIBRATOR
MODEL 745A-C90

Serials Prefixed: 953-

The 745A-C90 differs from the standard Model 745A in the following respects:

1. The specifications (listed in Table 1-1) have been revised in accordance with Contract Number DAAG11-71-C-0044.

2. The 745A-C90 is equipped with chassis slides.

   a. The following parts have been added:

      (1) Chassis Slides: Grant SS-168-NT-18-17 7/8 with BK-0106CRS hardware
      (2) Slide Bracket: -hp- Part No. 00745-91055L (2 ea.)
      (3) Slide Bracket: -hp- Part No. 00745-91055R (2 ea.)

   b. The side covers have been modified to permit installation of the chassis slides. Part numbers for the modified side covers are as follows:

      (1) Side Cover: -hp- Part No. 00745-91056L (1 ea.)
      (2) Side Cover: -hp- Part No. 00745-91056R (1 ea.)

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LIST OF TABLES (Cont'd)

Number		Page
5-5.	1 V, 10 V and 100 V Accuracy Checks	5-9
5-6.	Millivolt Range Accuracy Checks	5-15
5-7.	Adjustments	5-17
5-8.	Frequency Scale Tracking	5-28
5-9.	Mechanical Tracking Adjustments	5-30
5-10.	Factory-Selected Components	5-33
5-11.	Power Supply Data	5-43
5-12.	Voltage Distribution	5-44
6-1.	Replaceable Parts	6-3

LIST OF ILLUSTRATIONS

Number		Page
1-1.	Model 745A	1-0
3-1.	Front Panel Description	3-2
3-2.	Rear Panel Description	3-3
3-3.	Rear Output Connectors	3-5
3-4.	Remote Programing Methods	3-6
4-1.	Simplified Block Diagram	4-0
4-2.	Power Amplifier Bias Levels (Simplified)	4-6
4-3.	Simplified Power Amplifier	4-7
4-4.	Synchronous Demodulator Input	4-11
4-5.	Synchronous Demodulator Output	4-11
5-1.	Logarithmic Addition of Harmonic Components	5-4
5-2.	Conversion of dB to Percent	5-4
5-3.	Error Measurement Accuracy Check	5-5
5-4.	1 V, 10 V and 100 V Accuracy Checks	5-7
5-5.	1 V, 10 V and 100 V Accuracy Checks (Alternate Procedure)	5-10
5-6.	Millivolt Range Accuracy Checks	5-12
5-7.	Millivolt Range Accuracy Checks (Supplement Procedure)	5-14
5-8.	9:1 Frequency Divider Adjustment	5-21
5-9.	Modulator Balance Adjustment	5-22
5-10.	Modulator Unbalance	5-22
5-11.	Decade Frequency Divider Adjustment	5-23
5-12.	Decade Frequency Divider Adjustment	5-24
5-13.	100 kHz Response and 100 V Accuracy Adjustments	5-25
5-14.	100 kHz Response and 100 V Accuracy Adjustments (Alternate Procedure)	5-26
5-15.	Frequency Scale Alignment	5-29
5-16.	Frequency Scale Tracking	5-30
5-17.	Pushbutton Lamp Replacement	5-34
5-18.	Switch Contact Positioning	5-35
5-19.	Readout Lamp Replacement	5-35
5-20.	Reference Square Wave Generator (A1) Removal	5-36
5-21.	Decade Assembly (A10) Removal	5-37
5-22.	Oscillator Assembly (A12) Removal	5-38
5-23.	Front Panel Removal	5-39
5-24.	Dial Cord Replacement	5-40
5-25.	No Output Troubleshooting Tree	5-47/5-48
5-26.	Output Error Troubleshooting Tree	5-49/5-50
5-27.	Reference Square Wave Generator (A1) Troubleshooting Tree	5-51/5-52
5-28.	Error Amplifier and Sampling Amplifier (A2/A3) Troubleshooting Tree	5-53/5-54
5-29.	Preamplifier and Power Amplifier (A4/A5) Troubleshooting Tree	5-55/5-56
5-30.	Oscillator Troubleshooting Tree	5-57/5-58
5-31.	Decade Frequency Divider Troubleshooting Tree	5-59/5-60
5-32.	Adjustment Locations (Top View)	5-61/5-62
5-33.	Adjustment Locations (Bottom View)	5-61/5-62
6-1.	Mechanical Parts	6-2
6-2.	Mechanical Parts	6-3
7-1.	Functional Diagrams	7-3/7-4
7-2.	Chassis Top and Bottom View	7-5/7-6
7-3.	Reference Square Wave Generator (A1) Block Diagram	7-7/7-8
7-4.	+ and -15 V Power Supply (A1A1) Schematic and Component Location Diagram	7-9/7-10
7-5.	Reference Oven (A1A2) Schematic Diagram	7-11/7-12
7-6.	19.8 V Square Wave Generator (A1A3) Schematic and Component Location Diagram	7-13/7-14
7-7.	Oven Control and Switch Drive Generator (A1A4) Schematic and Component Location Diagram	7-15/7-16
7-8.	Error Amplifier (A2) Schematic and Component Location Diagram	7-17/7-18
7-9.	Sampling Amplifier (A3) Schematic and Component Location Diagram	7-19/7-20
7-10.	Preamplifier (A4) Schematic and Component Location Diagram	7-21/7-22
7-11.	Power Amplifier (A5) Schematic and Component Location Diagram	7-23/7-24
7-12.	High Frequency Range Switching (A6) Schematic and Component Location Diagram	7-25/7-26
7-13.	Low Frequency Range Switching (A7) Schematic and Component Location Diagram	7-27/7-28
7-14.	Regulated Power Supply (A8) Schematic and Component Location Diagram	7-29/7-30
7-15.	Primary Power Supply (A9) Schematic and Component Location Diagram	7-31/7-32
7-16.	Reference Divider (A10) and Readout Assembly (A11) Schematic	7-33/7-34
7-17.	Oscillator (A12) Block Diagram	7-35/7-36
7-18.	Variable Frequency Oscillator (A12A1) Schematic and Component Location Diagram	7-37/7-38
7-19.	Decade Frequency Dividers (A12A2A4) Schematic and Component Location Diagram	7-39/7-40
7-20.	5 MHz Oscillator and 9:1 Divider (A12A5) Schematic and Component Location Diagram	7-41/7-42
7-21.	RF Amplifier (A12A6) Schematic and Component Location Diagram	7-43/7-44
7-22.	Modulator (A12A7) Schematic and Component Location Diagram	7-45/7-46
7-23.	Output Amplifier (A12A8) Schematic and Component Location Diagram	7-47/7-48
7-24.	Front Panel Switching Logic (A13) Schematic and Component Location Diagram	7-49/7-50

TECHNICAL MANUAL)
TM 9-4931-700-14/1)

TM 9-4931-700-14/1
HEADQUARTERS,
DEPARTMENT OF THE ARMY
Washington, D.C. 18 October 1971

TABLE OF CONTENTS

Section		Page
I	GENERAL INFORMATION	1-1
1-1.	Description	1-1
1-4.	Accessories	1-1
1-6.	High Voltage Amplifier	1-1
1-8.	Instrument and Manual Identification	1-1
1-10.	Change Sheets	1-1
II	INSTALLATION	2-1
2-1.	Introduction	2-1
2-3.	Initial Inspection	2-1
2-5.	Power Requirements	2-1
2-7.	Grounding Requirements	2-1
2-10.	Installation	2-1
2-12.	Bench Mounting	2-1
2-14.	Rack Mounting	2-1
III	OPERATING INSTRUCTIONS	3-1
3-1.	Introduction	3-1
3-3.	Controls, Connectors and Indicators	3-1
3-5.	General Operating Information	3-1
3-6.	Output and Sense Connectors	3-1
3-10.	Sensing	3-1
3-18.	Counter Output	3-4
3-20.	Overload Lamp	3-4
3-23.	Basic Operating Procedure	3-4
3-24.	Error Measurement	3-5
3-26.	Using the Rear Output Connector	3-5
3-29.	Lamp Replacement	3-5
3-31.	Remote Programing	3-6
3-33.	Switch Closures	3-6
3-38.	Remote Frequency Programing	3-6
IV	THEORY OF OPERATION	4-1
4-1.	Introduction	4-1
4-7.	Block Diagram Description	4-1
4-21.	Functional Description	4-2
4-22.	Oscillator (A12)	4-2
4-64.	Oscillator Output Attenuator (P/O A10)	4-5
4-68.	Preamplifier (A4) and Power Amplifier (A5)	4-5
4-81.	Output and Feedback Switching	4-7
4-89.	Reference Square-Wave Generator (A-1)	4-8
4-107.	Reference Divider (A10)	4-9
4-111.	Sampling Amplifier (A3)	4-9
4-123.	Thermocouple Driver Gain Control (P/O A10)	4-10
4-126.	Error Amplifier (A2)	4-10
4-146.	Front Panel Switching Logic (A13)	4-12
V	MAINTENANCE	5-1
5-1.	Introduction	5-1
5-3.	Required Test Equipment	5-1
5-5.	Performance Checks	5-1
5-7.	Test Card	5-1
5-9.	Frequency Accuracy Check	5-1
5-11.	Distortion Checks	5-2
5-18.	Error Measurement Accuracy Check	5-5
5-20.	Voltage Accuracy and Load Regulation Checks	5-6
5-33.	Adjustment Procedures	5-17
5-35.	Test Equipment	5-17
5-37.	Test Point and Adjustment Location	5-17
5-40.	Printed-Circuit Board Removal	5-17
5-42.	Condensed Adjustments	5-18
5-44.	Power Supply and Bias Adjustments	5-18
5-64.	Oscillator Adjustments	5-20
5-77.	100 kHz Response and 100 V Accuracy Adjustments	5-24
5-80.	Frequency Scale Tracking Adjustments	5-27
5-86.	Error Scale Zero Adjustment	5-30
5-90.	Factory Selected Components	5-32
5-92.	Condensed Adjustment Procedure	5-33
5-97.	Removal and Replacement of Assemblies and Components	5-34
5-99.	Lamp Replacement	5-34
5-103.	Component Replacement	5-35
5-107.	Assembly Removal	5-35
5-109.	Dial Cord Replacement	5-40
5-116.	Troubleshooting	5-41
5-118.	Guidelines	5-41
5-120.	Symptoms	5-42
5-125.	Basic Checks	5-42
5-133.	Power Supplies	5-43
5-144.	Poor Line Regulation	5-45
5-146.	Output Distortion	5-45
5-149.	Oscillations	5-45
5-151.	Reed Relays	5-46
5-154.	AC Feedback Adjustments	5-46
VI	REPLACEMENT PARTS	6-1
6-1.	Introduction	6-1
6-4.	Ordering Information	6-1
6-6.	Non-Listed Parts	6-1
VII	CIRCUIT DIAGRAMS	7-1
7-1.	Introduction	7-1
7-3.	Functional Diagram	7-1
7-5.	Block Diagrams	7-1
7-7.	Schematic Diagrams	7-1
7-9.	Component Location Diagrams	7-1

APPENDICES
A. CODE LIST OF MANUFACTURERS
B. FORMS AND RECORDS
C. MANUAL BACKDATING CHANGES

LIST OF TABLES

Number		Page
1-1.	Specifications	1-2
1-2.	Accessories	1-1
3-1.	Remote Program Pin Connections	3-7
4-1.	Decade Frequency Dividers	4-4
4-2.	Modulator Frequency Relationships	4-5
5-1.	Required Test Equipment	5-0
5-2.	Frequency Accuracy Check	5-1
5-3.	Distortion and Noise Check (100 mV through 100 V Ranges)	5-3
5-4.	Distortion Check (1 mV and 10 mV Ranges)	5-5

Figure 1-1. Model 745A

745A-A-2328
745A-A-2329

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 745A AC Calibrator is a compact, wide-range ac calibration standard. The instrument provides highly-accurate ac calibration voltages from 0.1 mV rms to 110 V rms; or up to 1100 V rms using the companion Model 746A High Voltage Amplifier. The 745A output frequency is continuously adjustable from 10 Hz to 110 kHz in four overlapping decade ranges. The 745A output voltage is selectable in six decade ranges (1 mV through 100 V). A seventh range (1000 V ext.) is provided for use with the external high voltage amplifier. Output voltage can be varied from 10% of range to 110% of range in steps as small as 1 ppm of range. The six back-lighted voltage set controls provide a direct readout of the 745A voltage setting. In addition, the 745A is equipped with an error measurement function which can be used to provide a direct reading of calibration errors in percent of setting.

1-3. The 745A VOLTAGE RANGE, FREQUENCY RANGE, ERROR RANGE and SENSE functions are programmable through the rear panel REMOTE PROGRAM connector by transistor or switch closures to ground. The output frequency can also be varied remotely by applying an adjustable analog voltage or an adjustable resistance between the appropriate program line and ground. Refer to Section III for further information.

1-4. ACCESSORIES.

1-5. Table 1-2 is a list of accessories supplied with the Model 745A.

1-6. HIGH VOLTAGE AMPLIFIER.

1-7. The Hewlett-Packard Model 746A High Voltage Amplifier extends the output voltage capability of the 745A from 110 V rms to 1100 V rms, with a specified midband accuracy of 0.04% of setting. Consult the nearest Hewlett-Packard Sales and Service Office for further information (Office locations are listed in Appendix B).

1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

1-9. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument within the series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured. If the serial number of your instrument differs from the one on the title page of this manual, a change sheet will be supplied to make this manual compatable with newer instruments. The backdating information in Appendix C will adapt this manual to earlier instruments. All correspondence with Hewlett-Packard should include the complete serial number.

1-10. CHANGE SHEETS.

1-11. If the serial prefix of your instrument is greater than the one listed on the title page of this manual, a change sheet will be supplied. The change sheet is included to correct errors in the manual (ERRATA) and to make the manual compatable with instruments manufactured after the printing date of this manual (numbered changes).

Table 1-2. Accessories

DESCRIPTION	-HP- PART NO.
Accessory Kit includes the following:	00745-84401
Rack Mounting Kit	5060-0777
Printed Circuit Board Extender (22 pin)	5060-0630
Printed Circuit Board Extender (15 pin)	5060-0049
Printed Circuit Board Extender (10 pin)	5060-0091
Remote Program Connector	1251-0084

Refer to Table 1-1 (Page 1-2) for Specifications.

Table 1-1. Specifications

RANGES

Output Voltage Ranges:
6 ranges with 10% overrrange as follows:

RANGE	SETABILITY
1 mV	.100000 mV to 1.099999 mV in 1 nanovolt steps
10 mV	1.00000 mV to 10.99999 mV in 10 nanovolt steps
100 mV	10.0000 mV to 109.9999 mV in 100 nanovolt steps
1 V	.100000 V to 1.099999 V in 1 microvolt steps
10 V	1.00000 V to 10.99999 V in 10 microvolt steps
100 V	10.0000 V to 109.9999 V in 100 microvolt steps

Output Frequency Ranges:
continuously adjustable from 10 Hz to 110 kHz in 4 decade ranges with 10% overlap.

Error Measurement:
2 ranges with zero center dial, ± 0.3% or ± 3%.

PERFORMANCE RATING

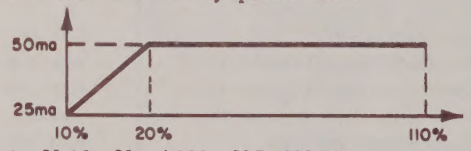
Accuracy:
accuracy holds for a 90-day period and is met after a 1-hour warmup period at 25°C ± 5°C with < 95% R.H.

Voltage:
specifications are relative to a 5 mA thermocouple calibrated by the National Bureau of Standards.

1 V, 10 V and 100 V RANGES:

FREQUENCY RANGE	COMBINED ACCURACY and LOAD REGULATION
50 Hz to 20 kHz	± (0.032% of setting + 0.002% of range + 10 μV)
20 Hz to 50 Hz 20 kHz to 110 kHz	± (0.062% of setting + 0.005% of range + 50 μV)
10 Hz to 20 Hz	± (0.212% of setting + 0.005% of range + 50 μV)

Load Regulation: On the 1 V, 10 V and 100 V ranges for output current equal to or less than that shown in the diagram below, a ± 0.002% of setting error is included in the accuracy specifications.



1 mV, 10 mV and 100 mV RANGES:

FREQUENCY RANGE	COMBINED ACCURACY and LOAD REGULATION
50 Hz to 20 kHz	± (0.04% of setting + 0.002% of range + 10 μV)
20 Hz to 50 Hz 20 kHz to 110 kHz	± (0.07% of setting + 0.005% of range + 50 μV)
10 Hz to 20 Hz	± (0.22% of setting + 0.005% of range + 50 μV)

Performance Rating (Cont'd)

Load Regulation: For a load of 3 kilohms, a ± 0.01% of setting error is included in the 1 mV, 10 mV and 100 mV range accuracy specifications.

Frequency:
± 2% of setting within temperature range of 20°C to 30°C.

Error Measurement:
± 0.51% of full scale.

Temperature Coefficient Frequency:
± 0.05% of end scale per °C from +4°C to 20°C and 30°C to 40°C.

Voltage Stability:
stability met after 1-hr warmup period at constant temperature with < 95% R.H.

Long-Term: ± 0.01% of setting for 6 mo.
Short-Term: ± 0.002% of setting for 24 hr.

OUTPUT CHARACTERISTICS

Total Distortion and Noise:
± (0.05% of setting + 10 μV over 100 kHz Bandwidth) on all ranges.

Total Distortion, Cycle-to-cycle Instability, and Noise:
Will cause < ± 0.005% of error when used to calibrate an average-responding or true rms-responding instrument from 1 mV to 110 V.

Load Capability:
1000 pF or 50 mA. (50 mA allows 800 pF at 100 V, 100 kHz.)

Line Regulation:
± 0.001% of setting change in output voltage for a ± 10% change in line voltage. (Included in accuracy specifications.)

Output Terminals:
high and low output terminals can be floated ± 500 V dc above chassis ground.

Counter Output:
rear-panel frequency counter output, 2.2 V ± 20%, protected against short circuits.

GENERAL

RFI:
meets Mil-I-6181D when using shielded output connectors.

Power Requirements:
115 or 230 V ± 10%, 48 Hz to 440 Hz, 70 W nominal, 100 W maximum.

Operating Temperature: 0°C to + 55°C.

Storage Temperature: -40°C to + 75°C.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the -hp- Model 745A AC Calibrator. Included are initial inspection procedures, power and grounding requirements, installation information and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. If the instrument was damaged in transit, file a claim with the carrier. Check for supplied accessories (Table 1-2) and test the electrical performance of the instrument using the performance check procedures outlined in Paragraph 5-5. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Model 745A can be operated from any source of 115 or 230 volts (± 10%), at 48 Hz to 440 Hz. With the instrument disconnected from the ac power source, set the rear panel slide switch (Item 26, Figure 3-2) to the position that corresponds with the line voltage to be used. Power dissipation is 100 watts maximum.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to earth ground.

2-10. INSTALLATION.

2-11. The Model 745A is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F) or the relative humidity exceeds 95%.

2-12. BENCH MOUNTING.

2-13. The Model 745A is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. RACK MOUNTING.

2-15. The Model 745A can be rack mounted by using the 8-1/2 in. rack mount kit (-hp- Part No. 5060-0777) supplied with the instrument. Instructions for the conversion are included with the kit. The rack mount for the Model 745A is an EIA standard width of 19 inches. When the instrument is mounted in a rack using the rack mount kit, additional support at the rear of the instrument should be provided if vibration or similar stress is likely.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains complete operating instructions for the Model 745A AC Calibrator. Included is a description of controls, general operating information, a basic operating procedure, and complete remote programming information.

3-3. CONTROLS, CONNECTORS AND INDICATORS.

3-4. Figures 3-1 and 3-2 illustrate and describe the function of all front and rear panel controls, connectors and indicators. The description of each item is keyed to the drawing within the figure.

3-5. GENERAL OPERATING INFORMATION.

3-6. OUTPUT AND SENSE CONNECTIONS.

3-7. It is recommended that shielded cables equipped with banana-plug connectors (-hp- 11000A Cable Assembly) be used for connections to the 745A OUTPUT and SENSE terminals. Although shielded cables can produce additional loading at high frequencies, the 745A capacitive load capability (800 pF at 100 V, 100 kHz) is sufficient to permit the use of standard-length cables for most instrument applications. Test results have indicated that shielded cables provide optimum voltage accuracy and measurement repeatability. In addition, when performing precision, low-level measurements using the 745A 1 mV, 10 mV and 100 mV ranges, the following steps should be taken to minimize undesirable ground currents.

a. Connect only the 745A OUTPUT to the input of the measuring equipment. Do not use remote SENSE terminals.

b. Connect only one instrument in a test arrangement to power-line ground. Connect all other instruments to the power source using three-prong to two-prong adapters (-hp- 1251-0048), leaving the ground leads disconnected.

3-8. Rear Output.

3-9. Output and sense connections can be made at the REAR OUTPUT connector (Item 19, Figure 3-2). The connector cap (Item 20, Figure 3-2) supplied with the instrument must be installed when using the front panel OUTPUT and SENSE terminals. Refer to Paragraph 3-26 for detailed instructions on using the REAR OUTPUT connector.

3-10. SENSING.

3-11. The 745A output voltage acccuracy is maintained by means of an automatic thermal transfer technique. The output voltage amplitude is compared to that of a precision square-wave reference twice each second. Any difference in amplitude between the output voltage and the reference is detected and used as an A.G.C. voltage to correct the output error.

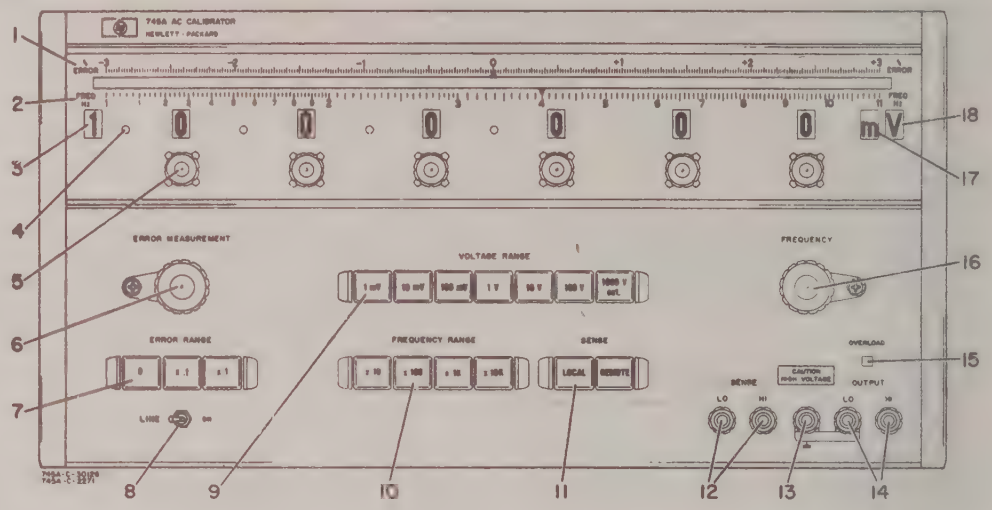
3-12. When LOCAL SENSE is selected, the 745A HI and LO OUTPUT is internally connected to the input of the error detection circuitry. If current is being drawn from the OUTPUT terminals, small voltage drops occur in the output leads since they are not perfect conductors. Although the voltage accuracy is maintained at the OUTPUT terminals, a slight error will be present at the load. The magnitude of this error is proportional to the load current and the resistance of the output leads.

3-13. The purpose of the remote SENSE terminals is to supply voltage feedback directly from the load to the input of the error detection circuitry. When REMOTE SENSE is selected and the SENSE terminals are connected to the load, any error that is present at the load is detected and the output voltage is corrected accordingly. This compensates for any voltage drops in the output leads. Voltage drops in the sense leads are insignificant since very little current flows in these leads.

3-14. When REMOTE SENSE is selected without external connections to the SENSE terminals, the output voltage is no longer applied to the error detection circuitry. The error detection circuitry, in turn, senses this as a low voltage condition and attempts to correct by increasing the output voltage. This results in approximately 40% increase in the output voltage and causes the OVERLOAD lamp to illuminate.

3-15. Local sensing can be used whenever little output current is required from the 745A or whenever the output leads are very short. Connections to the SENSE terminals are not required when LOCAL SENSE is selected.

3-16. Remote sensing should always be used for applications requiring optimum voltage accuracy. Sensing is particularly important if the output leads are long or if the load is a low impedance. If remote sensing is to be used, connect the HI SENSE terminal to the same point (at the load) as the HI OUTPUT; connect the LO SENSE terminal to the same point as the LO OUTPUT. Remote sensing can be used only on the 1 V range and above. LOCAL SENSE is automatically selected on the millivolt ranges.



1 % ERROR Scale: Indicates the accuracy deviation of an instrument being calibrated. Scale is direct reading when X1 ERROR RANGE pushbutton is depressed; scale indication must be divided by ten when X.1 ERROR RANGE pushbutton is depressed. Scale pointer is moved with ERROR MEASUREMENT Control.

2 FREQUENCY Scale: Indicates the frequency of the 745A output voltage. The depressed FREQUENCY RANGE pushbutton indicates the multiplier to be used with the FREQUENCY Scale indication.

3 "1" Indicator: Lights when first Voltage Set Control is rotated fully cw. Indicates an output at or above the selected voltage range.

4 Decimal Indicators: Light to indicate the position of the decimal point in the voltage display.

5 Voltage Set Controls: Control the 745A output voltage. Voltage dials in conjunction with decimal indicators and "M" and "V" indicators directly display the rms output voltage.

6 ERROR MEASUREMENT Control: Varies the selected 745A output voltage up to ±0.3% when the X.1 ERROR RANGE is selected; varies the output up to ±3% when the X1 ERROR RANGE is selected. The setting of the ERROR MEASUREMENT Control is indicated on the % ERROR Scale. ERROR MEASUREMENT Control has no effect on the output when 0 ERROR RANGE is selected.

7 ERROR RANGE Pushbuttons: Select the Error Measurement Function and Range. When the 0 pushbutton is depressed, the Error Measurement function is inactivated. The X.1 pushbutton sets the range of the ERROR MEASUREMENT Control to ±0.3% variation of the output voltage. The X1 pushbutton sets the range to ±3% variation of the output.

8 LINE ON Switch: Applies line voltage to the instrument when moved to the ON position.

9 VOLTAGE RANGE Pushbuttons: Select one of seven full scale voltage ranges. Output voltage is variable from 10% to 110% of the selected range.

10 FREQUENCY RANGE Pushbuttons: Select the desired output frequency range and indicate the multiplier to be used in conjunction with the FREQUENCY Scale indication. The FREQUENCY RANGE Pushbuttons provide the following ranges of output frequency.

X10 - 10 Hz to 110 Hz
X100 - 100 Hz to 1.1 kHz
X1K - 1 kHz to 11 kHz
X10K - 10 kHz to 110 kHz

11 SENSE Pushbuttons: Select Local or Remote sensing. When LOCAL SENSE is selected, an internal connection is made between the HI OUTPUT and HI SENSE Terminals and between the LO OUTPUT and LO SENSE Terminals. When REMOTE SENSE is selected, the SENSE terminals must be connected in parallel with the OUTPUT terminals at the load. LOCAL SENSE is automatically selected when the 1 mV, 10 mV or 100 mV VOLTAGE RANGE is selected.

12 SENSE Terminals: Accept leads for remote sensing of output voltage when REMOTE SENSE Pushbutton is depressed.

13 ⏚ Terminal: Accepts lead for connecting to power line ground. Terminal strap may be connected to LO OUTPUT terminal to reference output to ground. This terminal and the instrument case are connected to power line ground through the center conductor of the line power cord.

Figure 3-1. Front Panel Description

14 OUTPUT Terminals: Accept leads for application of output voltage to remote location.

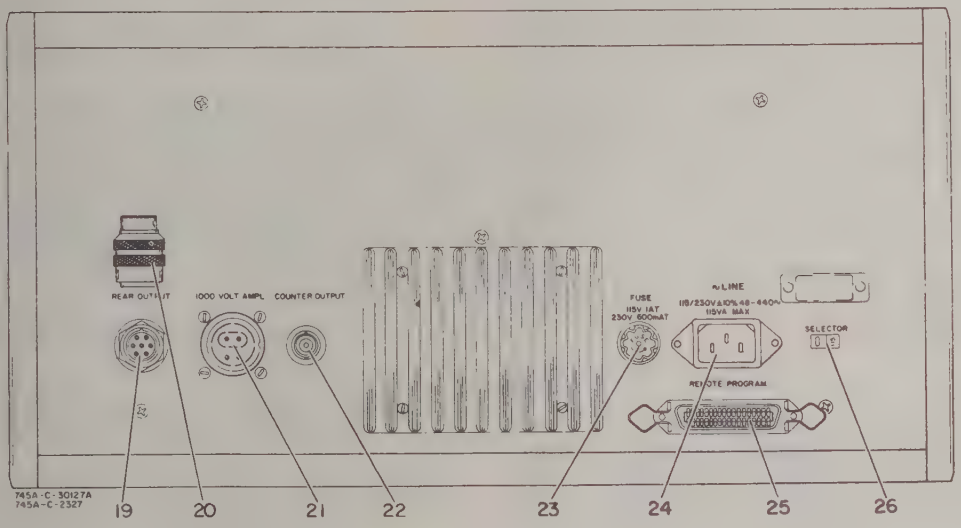
15 OVERLOAD Indicator: Indicates an overload condition in the output. May also light if proper connections are not made to the SENSE Terminals when REMOTE SENSE is selected. Light goes out when overload condition is removed or when the SENSE Leads are connected properly.

16 FREQUENCY Control: Varies the output frequency within the limits of the selected FREQUENCY RANGE.

17 "m" Indicator: Lights when the 1 mV, 10 mV or 100 mV VOLTAGE RANGE is selected.

18 "V" Indicator: Lights at all times to indicate volts or millivolts, depending on whether the "m" indicator lights.

Figure 3-1. Front Panel Description (Cont'd)



19 REAR OUTPUT Connector: Provides OUTPUT and SENSE connections at rear of instrument and also accepts connector and cable for input connection to Model 746A High Voltage Amplifier.

20 Connector Cap (P19): Shorting connector for REAR OUTPUT must be installed (except when Model 746A is connected) when using front panel OUTPUT and SENSE terminals.

21 1000 V AMPL. Connector: Accepts connector and cable for connection to Model 746A High Voltage Amplifier.

22 COUNTER OUTPUT Connector: Accepts connector and cable for connection to an electronic counter. Signal at COUNTER OUTPUT Connector is a constant 2.2 V rms at the same frequency as the instrument output.

23 Fuse: Protects internal primary power supply.

24 AC Power Connector: Accepts power cable supplied with the instrument.

25 REMOTE PROGRAM Connector: Accepts mating connector with leads for remotely programming all instrument functions and ranges normally selected with the front panel pushbuttons. In addition, the FREQUENCY control can be remotely programmed through the REMOTE PROGRAM Connector.

26 Line Voltage Selector Switch: Sets the instrument for either 115 Vac or 230 Vac operation.

Figure 3-2. Rear Panel Description

3-17. Since remote sensing cannot be used on the 1 mV, 10 mV and 100 mV ranges, the load regulation is limited by the 745A output impedance (< 1 ohm) and the resistance of the output leads. In order to maintain the output voltage accuracy on the millivolt ranges, the load impedance should be greater than 3 kilohms.

3-18. COUNTER OUTPUT.

3-19. The 745A output frequency can be monitored at the rear panel COUNTER OUTPUT connector. The signal output at the connector is 2.2 V rms regardless of the selected VOLTAGE RANGE or voltage setting. The signal can be used to verify the FREQUENCY scale indication or to provide greater accuracy and resolution for critical frequency settings.

3-20. OVERLOAD LAMP.

3-21. The front panel OVERLOAD lamp will illuminate to indicate an overload condition in the 745A output. An overload condition results:

a. When the load impedance/output voltage combination exceeds the output current capabiltiy of the 745A.

b. When SENSE terminals are not connected in REMOTE SENSE.

c. When the connector cap (or Model 746A cable plug-in) is not installed in the REAR OUTPUT connector.

3-22. When the overload indication is caused by excessive load current, the 745A power supplies will current limit and the internal overload protection circuitry will be actuated. This, in turn, limits the output voltage to a safe level to protect the instrument. If the overload condition is caused by loss of feedback (SENSE terminals not connected in REMOTE SENSE), the output voltage will increase by approximately 40%. The overload circuitry will reset automatically and the output will return to normal when the overload condition is removed. When an overload occurs at high frequencies, the output may require up to 15 seconds to recover once the cause of the overload is corrected.

NOTE

With the Model 746A High Voltage Amplifier connected to the 745A (746A OUTPUT - OFF), it is normal for the OVERLOAD lamp to illuminate when the 745A frequency setting is above 50 kHz (nominal) and the 1000 V EXT. VOLTAGE RANGE is selected.

3-23. BASIC OPERATING PROCEDURE.

a. Set the rear panel 115 V/230 V slide switch (Item 26, Figure 3-2) to correspond with the line voltage to be used.

b. Verify that a 1 A slow-blow fuse (115 V operation) or a 0.6 A slow-blow fuse (230 V operation) is installed in the rear panel fuseholder.

c. Connect the detachable ac power cord to the rear panel power receptacle and to the power source (115 V or 230 V, 48 Hz to 440 Hz).

d. Set the LINE switch to the ON position. The following front panel pushbuttons will illuminate:

VOLTAGE RANGE ..... 1 mV
FREQUENCY RANGE X1K
ERROR RANGE 0
SENSE ..... LOCAL

e. To ensure operation at specified accuracies, allow a warmup period of at least one hour before proceeding.

f. Connect the 745A OUTPUT terminals to an ac voltmeter or other instrument to be calibrated.

g. If remote sensing is desired, connect the SENSE terminals to the same point as the OUTPUT terminals (Sensing is discussed in Paragraph 3-10.).

NOTE

1. HI SENSE must be connected to the same point as HI OUTPUT; LO SENSE must be connected to the same point as LO OUTPUT.

2. Remote sensing is not operative on the mV ranges.

h. Select the desired FREQUENCY RANGE. Frequency limits available within each range are as follows:

X10: 10 Hz to 110 Hz
X100: 100 Hz to 1.1 kHz
X1K: 1 kHz to 11 kHz
X10K: 10 kHz to 110 kHz

i. Set the FREQUENCY control for the desired indication on the FREQUENCY scale. The 745A output frequency is the product of the FREQUENCY scale indication and the selected FREQUENCY RANGE.

j. Select the desired VOLTAGE RANGE. Voltage limits within each range are as follows:

1 mV: 100 μV to 1.099999 mV
10 mV: 1 mV to 10.99999 mV
100 mV: 10 mV to 109.0000 mV
1 V: 100 mV to 1.099999 V
10 V: 1 V to 10.99999 V
100 V: 10 V to 109.9999 V
1000 V: (Inoperative without Model 746A High Voltage Amplifier)

k. Adjust the voltage set controls for the desired output voltage. The 745A rms output voltage is equal (within specified tolerances) to the value indicated on the voltage set dials.

NOTE

If the 0 ERROR RANGE is not selected, an output error is introduced that is equal and opposite to the percentage indicated on the % ERROR scale. For this reason, be sure to select the 0 ERROR RANGE when the error measurement feature is not being used.

l. Select LOCAL or REMOTE SENSE. If REMOTE SENSE is selected, sense leads must be connected to the load (Step g) REMOTE SENSE is inoperative on the mV ranges.

3-24. ERROR MEASUREMENT.

3-25. The 745A error measurement feature permits direct measurement of the percent accuracy deviation (up to ± 3%) of an ac voltmeter or other instrument being calibrated. The percentage of error is indicated on the % ERROR scale; the selected ERROR RANGE determines the multiplier to be used in conjunction with the scale indication. To make an error measurement, proceed as follows:

a. Select the 1 mV range to decrease output voltage to a safe level.

b. Connect the 745A OUTPUT terminals to the instrument under test. If remote sensing is to be used, connect SENSE terminals to the load (Paragraph 3-23, Step g).

c. Set the 745A controls for the desired output voltage and frequency.

d. Select the X.1 or X1 ERROR RANGE. The X.1 pushbutton sets the error range at ± 0.3% of the 745A output; the X1 pushbutton sets the range to ± 3%.

e. Vary the ERROR MEASUREMENT until the instrument under test indicates the exact voltage displayed on the 745A voltage set dials.

f. Observe the calibration error of the instrument under test as indicated on the 745A % ERROR scale. If the X.1 ERROR RANGE is used, the error is 1/10 the % ERROR scale indication.

NOTE

The % ERROR indication is expressed in terms of the calibration voltage. For example, an indication of -1.5% when calibrating an ac voltmeter means the voltmeter is reading 1.5% low at the calibration voltage. The 745A output must then be increased by 1.5% to cause the ac voltmeter to indicate the calibration voltage. If the selected calibration voltage is 3 V, the error is 1.5% of 3 V or 0.045 V. The ac voltmeter indication is, therefore, 0.045 V low with a 3 V input applied.

g. When the error measurement feature is not being used, the 0 ERROR RANGE must be selected to maintain an accurate voltage at the OUTPUT terminals.

3-26. USING THE REAR OUTPUT CONNECTOR.

3-27. A mating connector (-hp- Part No. 1251-0469) with four connector pins (-hp- Part No. 1251-0470) is required for OUTPUT and SENSE connections to the REAR OUTPUT connector. Although shielded cabling is recommended, any 4-conductor cable can be used providing the total resistance in the OUTPUT leads does not exceed 0.5 ohm. The REAR OUTPUT connector pin-numbering sequence and the function of each pin is shown in Figure 3-3.

3-28. The LOCAL and REMOTE SENSE pushbuttons have no effect when using the REAR OUTPUT connector. LOCAL SENSE is automatically selected and internal sensing is provided on the millivolt ranges. On the 1 V, 10 V and 100 V ranges, however, sensing is determined solely by the cable connections. The HI SENSE line must be connected to the same point as HI OUTPUT; LO SENSE must be connected to the same point as LO OUTPUT.

3-29. LAMP REPLACEMENT.

3-30. A package containing 12 spare lamps (-hp- Part No. 1450-0356) for the front panel pushbuttons, 12 lamps (-hp- Part No. 2140-0246) for the Readout Assembly and a lamp extractor (-hp- Part No. 4040-0427) is located beneath the Top Trim (MP28, Figure 6-1). Refer to Paragraph 5-99 for a complete Lamp Replacement procedure.

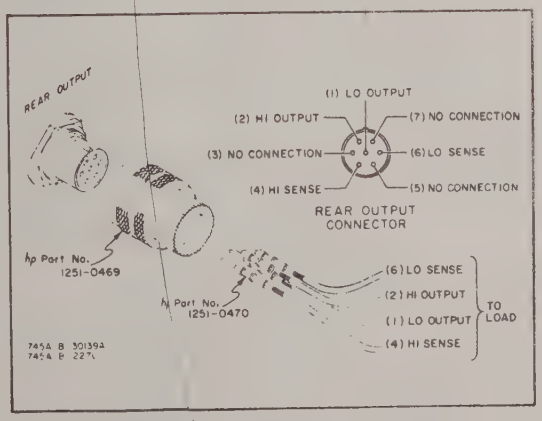


Figure 3-3. Rear Output Connectors

3-31. REMOTE PROGRAMING.

3-32. All 745A functions and ranges that are selected with the front panel pushbuttons can also be selected by applying circuit ground to the appropriate pins on the rear panel REMOTE PROGRAM connector (J23). In addition, the output frequency can be varied within each FREQUENCY RANGE by applying a variable resistance or a variable dc voltage between circuit ground and the Remote Frequency control line (J23, pin 28).

3-33. SWITCH CLOSURES.

3-34. Switch closures between the remote control lines and circuit ground can be either momentary (except Remote Frequency Switch line) or sustained. Regardless of which switch closure is used, the front panel pushbuttons will light to indicate the programed state of the instrument. Momentary switch closures cause the instrument to operate in the same manner as when using the front panel pushbuttons.

3-35. Sustained switch closures cause the front panel pushbuttons to have little control of the instrument. For example, if the 1 V range control line is connected to circuit ground through a sustained switch closure, other voltage ranges cannot be selected by pressing the VOLTAGE RANGE pushbuttons. When using sustained switch closures, care should be taken to avoid simultaneous selection of two or more Voltage, Frequency or Error Ranges. Simultaneous selection will not damage the 745A but will produce a distorted, uncontrolled output signal.

3-36. Several remote programing methods are illustrated in Figure 3-4.

3-37. Table 3-1 is a list of the REMOTE PROGRAM connector (J23) pin and line numbers and the various functions they control. The pin numbers are printed on the REMOTE PROGRAM connector. A mating connector (-hp- Part No. 1251-0084) and a 20-conductor cable are required for a complete remote programing capability.

3-38. REMOTE FREQUENCY PROGRAMING.

3-39. The 745A output frequency can be varied by applying a variable resistance or variable dc voltage between circuit ground and the Remote Frequency control line (J23 pin 28). The Remote Frequency Control line is operative

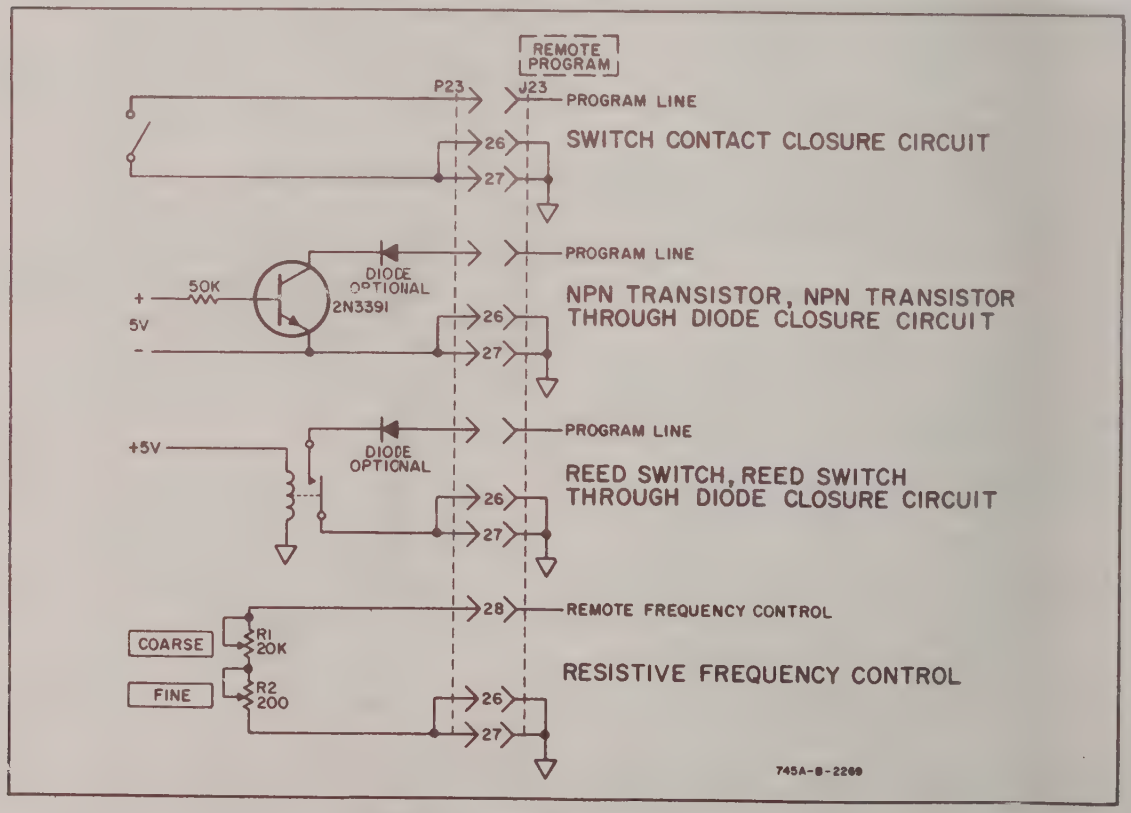


Figure 3-4. Remote Programing Methods

only when circuit ground is applied to the Remote Frequency Switch line (J23 pin 10).

3-40. The resistance or voltage values required to produce specific output frequencies vary somewhat from instrument to instrument; however, once selected, remain relatively stable for long periods. The resistance to ground or dc voltage applied to the Remote Frequency Control line can be set to produce any output frequency within the range of 10 Hz to 110 Hz on the X10 FREQUENCY RANGE. The output frequency can then be programed in decade multiples of this set frequency by selecting the X100, X1K or X10K FREQUENCY RANGE. If continuous frequency variation is desired, a variable resistance to ground or variable voltage can be applied to the Remote Frequency Control line.

3-41. Figure 3-4 illustrates a typical method for determining the required resistance between the Remote Frequency Control line and circuit ground to produce the desired output frequency. Once the required resistance is determined, a fixed resistor of equal value can be substituted. To determine the required resistance, proceed as follows:

a. Connect the frequency control circuit between circuit ground (J23 pins 26, 27) and pin 28 of the REMOTE PROGRAM connector.

Table 3-1. REMOTE PROGRAM Pin Connections

FUNCTION		PIN AND LINE NO.
0	ERROR RANGE	23
X.1		24
X1		25
1 mV	VOLTAGE RANGE	3
10 mV		2
100 mV		1
1 V		19
10 V		20
100 V		21
1000 V		22
X10	FREQUENCY RANGE	9
X100		8
X1K		7
X10K		6
Remote Frequency Switch		10
**Remote Frequency Control		28
LOCAL SENSE		5
REMOTE SENSE		4
Circuit Ground (⏚)		26, 27

* Operative only with external amplifier.
** Operative only when Remote Frequency Switch (Pin 10) is switched to ground.

b. Connect an electronic counter (-hp- Model 5216A) to the rear panel COUNTER OUTPUT connector.

c. Select the desired FREQUENCY RANGE (either at the front panel or by remote control). Frequency limits within each range are as follows:

X10: 10 Hz to 110 Hz
X100: 100 Hz to 1.1 kHz
X1K: 1 kHz to 11 kHz
X10K: 10 kHz to 110 kHz

d. Set R1 (Coarse) to minimum resistance; set R2 (Fine) to mid-value.

e. Apply circuit ground to the Remote Frequency Switch line (J23 pin 10).

f. While observing the counter indication, increase the resistance of R1 until the output frequency is approximately equal to the desired setting.

NOTE

1) Some frequencies can be obtained with two different settings of R1. The *correct* setting is the lower resistance setting.

2) The 745A output frequency for a given FREQUENCY RANGE must be within the limits listed in Step c.

g. Adjust R2 to accurately set the output frequency.

h. If a fixed frequency setting is desired, remove the R1/R2 combination and substitute a fixed resistor of equal value between the Remote Frequency Control line and circuit ground.

3-42. The preceeding procedure outlined a method of determining the value of resistance required to produce a single output frequency. If several frequency settings are desired, a rotary switch selecting one of several resistors can be used in place of a single fixed resistor. In addition, a second deck of the rotary switch could be connected to the various Frequency Range control lines to automatically select the desired FREQUENCY RANGE. A potentiometer can also be used in place of a fixed resistance providing its value is selected (or padded) to prevent operation at the higher resistance setting (Note 1). Operation at the higher setting will not damage the 745A but will cause distortion and instability. A potentiometer is properly selected or padded when the following requirements are met:

a. When increasing the resistance decreases the 745A output frequency throughout the entire range of the potentiometer.

b. When the 745A output frequency for a given FREQUENCY RANGE is within specified limits (Paragraph 3-41, Step c) regardless of the potentiometer setting.

NOTE

The frequency change to resistance change ratio becomes quite high near the low end of the frequency scale on each range. Additional linearity or resolution can be obtained by using a logarithmic-taper or multi-turn potentiometer for the Frequency Control.

3-43. Controlling the Frequency with a Voltage.

3-44. The output frequency can also be controlled by applying a dc voltage to the Remote Frequency Control line. To control the frequency with a voltage, the required voltage for a given frequency must first be determined. The following procedure can be used to determine the amount of voltage required to produce a given output frequency:

a. Perform the procedure outlined in Paragraph 3-41, Steps a through g.

b. With the resistive Frequency Control connected and adjusted, measure the dc voltage between the Remote Frequency Control line (pin 28) and circuit ground (pin 26 or 27). Use a high impedance dc voltmeter (-hp- Model 412A) for the measurement. The measured voltage is the correct voltage to apply to the Remote Frequency Control line.

CAUTION

DO NOT EXCEED 10 Vdc BETWEEN THE REMOTE FREQUENCY CONTROL LINE AND CIRCUIT GROUND.

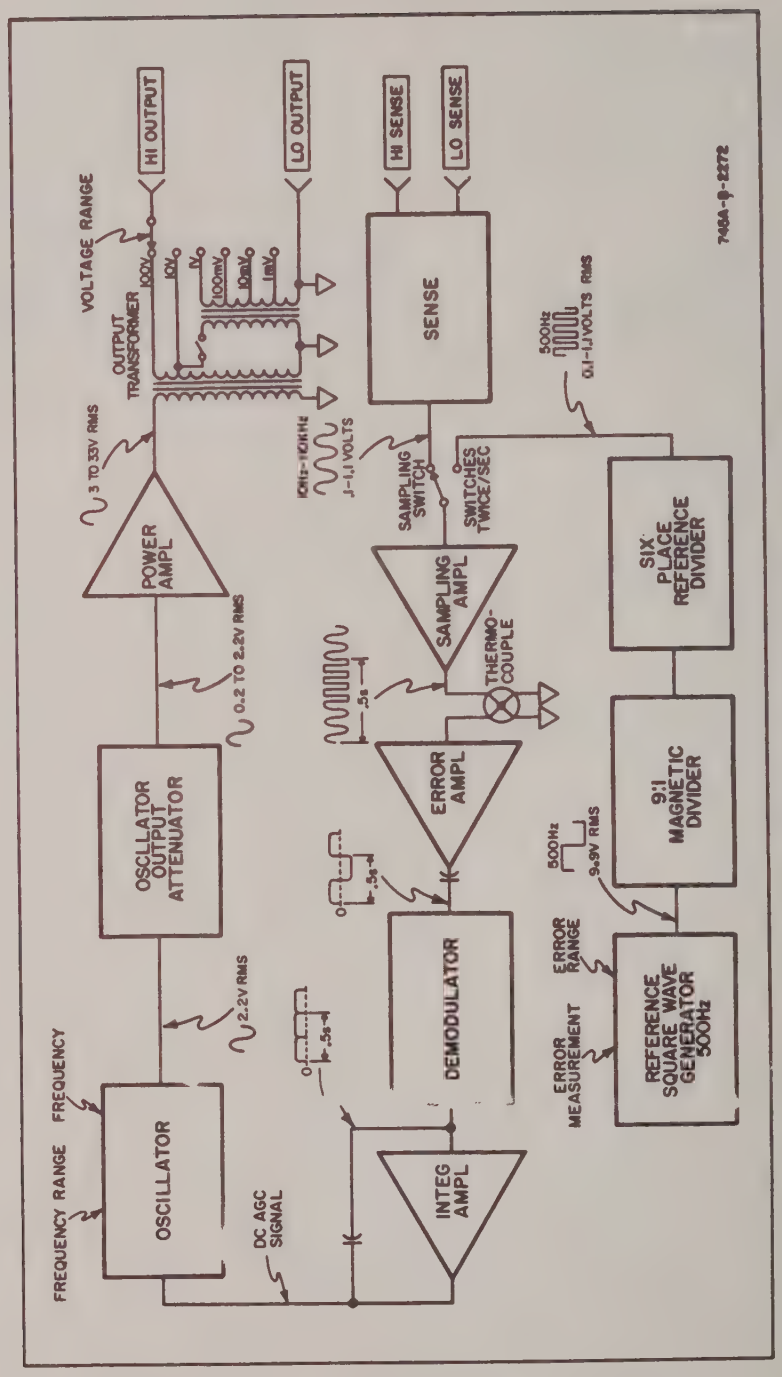


Figure 4-1. Simplified Block Diagram

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. The Hewlett-Packard Model 745A is a versatile, wide-range AC Calibrator. The instrument provides highly accurate ac calibration voltages from 0.100000 mV rms to 109.9999 V rms, over a frequency range of 10 Hz to 110 kHz.

4-3. The 745A output voltage is selectable in six ranges of 1 mV to 100 V full scale with 10% overrange. A precision six-place reference divider permits the output voltage to be varied from 10% of range to 110% of range in steps as small as 1 ppm of range.

4-4. The output voltage accuracy of the Model 745A is maintained by means of an automatic thermal transfer technique. The output voltage amplitude is compared to that of a precision square-wave reference twice each second. Any difference (error) between the output voltage and the reference is detected and used as an AGC voltage to correct the output error.

4-5. The 745A output frequency is continuously adjustable from 10 Hz to 110 kHz in four overlapping decade frequency ranges.

4-6. The Model 745A is equipped with a unique error measurement feature which permits direct measurement of calibration errors in percent of setting.

4-7. BLOCK DIAGRAM DESCRIPTION.

4-8. Refer to the Simplified Block Diagram (Figure 4-1) for the following discussion.

4-9. The source of the 745A output signal is a variable frequency Oscillator (A12) controlled by the front panel FREQUENCY RANGE pushbuttons and the FREQUENCY control. The output of the Oscillator is a low distortion, 2.2 V rms sine wave which can be varied in frequency from 10 Hz to 110 kHz.

4-10. The Oscillator output signal is coupled through the Oscillator Output Attenuator to the input of the Power Amplifier. The Oscillator Output Attenuator is a variable resistive divider controlled by the first two voltage-set controls. The purpose of this attenuator is to provide the input level required by the Power Amplifier to produce a voltage at the OUTPUT terminals that is approximately equal to the voltage setting. The remaining output error is corrected by the automatic gain control.

4-11. The 0.2 V rms to 2.2 V rms signal from the Oscillator Output Attenuator is amplified by the Power Amplifier and is transformer-coupled to the OUTPUT terminals. The voltage amplitude at the output of the Power Amplifier varies from 3 V rms to 33 V rms as a function of the voltage setting. Voltage range switching is accomplished by means of reed relays which are used to select the appropriate tap on the secondary of the step-up or step-down output transformer. The reed relays are actuated in response to commands from the VOLTAGE RANGE pushbutton switches.

4-12. Since the 745A Oscillator and Power Amplifier are designed for optimum stability, it would be possible to obtain ac voltages with midband accuracies in the ± 1% region without the benefit of sophisticated AGC circuitry. In order to obtain the high degree of accuracy, stability and resolution provided by the Model 745A, however, it is necessary to maintain precise control of the output level.

4-13. The most practical method for obtaining high-accuracy ac is to compare the magnitude of the unknown ac voltage to that of a precision dc reference. In the Model 745A, the reference consists of two precision voltages, +9.9 Vdc and −9.9 Vdc, which are referenced to a highly stable zener diode located in a temperature-controlled oven. In the Square-Wave Generator, a unique gating circuit is used to convert these precision voltages to a 19.8 V p-p, 500 Hz, square wave. The rms accuracy of the square wave is approximately 0.001%. The 9.9 V rms (19.8 V p-p) square wave is applied to a 9:1 Magnetic Divider which reduces the amplitude to 1.1 V rms at the input of the six-place Reference Divider. The output of the Reference Divider is a highly accurate 500 Hz square wave which can be varied in amplitude from 0.100000 V rms to 1.099999 V rms by means of the front panel voltage-set controls.

4-14. On the 1 volt range, the voltage at the SENSE terminals (connected to the OUTPUT terminals) is applied directly to the input of the Sampling Switch. The Sampling Switch alternates between the sine-wave feedback and the square-wave reference at the 2 Hz rate.

4-15. The sampled signal, consisting of the sine-wave feedback and the reference square wave, is amplified by the Sampling Amplifier and applied to a single thermocouple. The average output of the thermocouple is approximately 7 mVdc The effects of thermocouple drift are minimized due to the continuous comparison of the sine-wave feedback and the square-wave reference. If the rms value of the sine wave differs from that of the square wave, the thermocouple output voltage will change each time the Sampling Switch changes state. These changes, therefore, occur at a 2 Hz rate, in step with the Sampling Switch, and are superimposed on the nominal 7 mVdc output of the

thermocouple. If the sine-wave feedback and the square-wave reference have identical rms values, the thermocouple output will remain constant.

4-16. The thermocouple output is amplified by the Error Amplifier and is ac-coupled to the Demodulator. The output of the Error Amplifier resembles a low amplitude 2 Hz square wave. The square-wave amplitude is proportional to the difference or "error" between the sine-wave feedback and the square-wave reference. Phase of the 2 Hz error signal is determined by which of the sampled signals is greater in rms amplitude.

4-17. The Demodulator operates at the 2 Hz sample rate and synchronously detects the rms error (amplitude and polarity) of the sine-wave feedback.

4-18. The Integrator Amplifier amplifies and filters the demodulated error signal. The output of the Integrator Amplifier is approximately -1 Vdc when no error is detected between the sine-wave feedback and the square-wave reference. If the sine-wave feedback is lower than the reference square wave, the Integrator Amplifier output becomes more negative. Conversely, if the sine wave is greater, the Integrator Amplifier output becomes more positive.

4-19. The output of the Integrator Amplifier is applied to the Oscillator as an AGC voltage. The AGC voltage changes the Oscillator output level to correct for the rms error at the 745A OUTPUT terminals.

4-20. At this point, it would be beneficial to clarify the reason for using a square-wave reference as opposed to straight dc. Primarily, the use of a square-wave reference overcomes the inherent problems created by dc reversal error in most thermocouples. Since the 500 Hz square wave applied to the heater of the thermocouple is switched positive and negative at a rapid rate, the thermocouple output is equal to the average of both directions of current. In addition, the square-wave reference permits the use of magnetic reference dividers which overcome the stability limitations of resistive dividers.

4-21. FUNCTIONAL DESCRIPTION.

4-22. OSCILLATOR (A12).

4-23. Refer to the Oscillator Block Diagram (Figure 7-17) for the following discussion.

4-24. The Oscillator section generates the 10 Hz to 110 kHz 745A output frequency which is controlled by the front panel FREQUENCY control and FREQUENCY RANGE pushbuttons. This is accomplished by modulating a crystal-controlled fixed frequency of 555 kHz (developed in A12A5 and amplified in A12A6) with a variable frequency from the Variable Frequency Oscillator (A12A1) or one of the Decade Frequency Dividers (A12A2 through A12A4). The Modulator (A12A7) produces a composite signal which contains a 10 Hz to 110 kHz frequency representing the difference between the fixed and variable frequency inputs. This difference frequency is amplified in the Output Amplifier (A12A8) and applied to the Preamplifier Assembly (A4) through the Oscillator Output Attenuator (P/O A10). The Oscillator output amplitude (2.2 V rms nominal) is controlled by an AGC voltage applied to the RF Amplifier (A12A6) from the Error Amplifier Assembly (A2).

4-25. 5 MHz Oscillator and 9:1 Divider (A12A5).

4-26. Refer to the Oscillator Block Diagram (Figure 7-17) and Schematic No. 16 for the following discussion.

4-27. The 5 MHz oscillator generates a stable, 5 MHz signal which is used by the 9:1 divider stage and the Decade Frequency Dividers (A12A2 through A12A4). The 9:1 divider stage divides the 5 MHz frequency to 555.555 kHz for use in the Modulator (A12A7).

4-28. The 5 MHz signal is generated by the crystal-controlled oscillator consisting of A12A5Y1, Q1 and associated circuitry. Oscillation is maintained by regenerative feedback from the collector of Q1 to the junction of Y1 and C3. The 5 MHz signal is coupled through pin 15 to the Decade Frequency Dividers and through A12A5C6 to the emitter of buffer amplifier A12A5Q2. Transformer A12A5T1 is adjusted for maximum amplitude of the 5 MHz signal at TP1. The 9:1 divider is a 555.555 kHz grounded-base Colpitts oscillator that is synchronized by the 5 MHz signal. Variable inductor L2 is adjusted to produce the required frequency of 555.555 kHz at A12A5TP2.

4-29. The 555 kHz signal is coupled through A12A5C12 to the emitter of buffer amplifier Q4. Output Transformer T2 is adjusted to produce maximum signal amplitude between pins 1 and 2 (circuit ground). The 555 kHz, 0.14 V rms (nominal) is applied through pins 1 and 2 of A12A5 to the input of the RF Amplifier (A12A6).

4-30. RF Amplifier (A12A6).

4-31. Refer to the Oscillator Block Diagram (Figure 7-17) and Schematic No. 17 for the following discussion.

4-32. The RF Amplifier operates as a gain control for the oscillator output and also serves as a buffer between the 5 MHz Oscillator and 9:1 Divider (A12A5) and the Modulator (A12A7). The AGC voltage from the Error Amplifier Assembly (A2) varies the level of the 555 kHz signal in the gain control stage. The buffer stage provides additional isolation and supplies the current required to drive the fixed-frequency input of the Modulator.

4-33. The 555 kHz signal from A12A5 is coupled through A12A6C1 to the gain-control amplifier consisting of A12A6Q1, Q2, T1, L2 and associated circuitry. A 555 kHz parallel-resonant circuit is formed by the series inductance of A12A6L2 and T1 which is connected in parallel with A12A6C3. Inductor L2 is adjusted to produce optimum resonance of the tuned circuit which results in minimum

dc voltage drop across A12A6R3 and further establishes the dc bias level of the amplifier. Transformer T1 is adjusted for maximum ac coupling which, due to the internal AGC loop, (Paragraph 4-34) results in minimum signal amplitude on the collector of A12A6Q2 (TP3).

4-34. The gain of the RF amplifier stage is determined by the conduction of A12A6Q3 which, in turn, is controlled by the signal from the secondary of T1 in conjunction with the AGC voltage from the Error Amplifier Assembly (A2). The 555 kHz signal on the secondary of T1 is developed across A12A6C4 and C8 which provide an ac return path through circuit ground. The signal developed across C4 is coupled through C5 to the junction of CR2 and CR3. During the positive half-cycle, C5 charges through CR2, C6 and the emitter-base junction of Q3. The average dc level developed across C6 controls the conduction of Q3 which further effects the dc operating point of the RF amplifier. As the signal coupled through C5 increases, the dc level across C6 becomes more positive. This increase is applied to the bases of Q1 and Q2 causing the gain of the RF amplifier to decrease. Conversely, if the signal level decreases, the dc level applied to the bases of Q1 and Q2 becomes more negative causing the gain of the amplifier to increase. The purpose of this internal gain-control loop is to maintain a constant output amplitude despite variations in the amplitude of the input signal. The output amplitude maintained by this internal control loop, however, is controlled by the AGC voltage from the Error Amplifier Assembly (A2). The AGC voltage from A2 determines the negative dc bias level applied to the anode of CR3. During the negative half-cycle, C5 discharges through CR3 only when the peak amplitude becomes more negative than the voltage applied to the anode of CR3. Since the discharge of C5 is very slight, CR2 conducts only when the amplitude of the positive peaks exceeds the net charge across C5. If the AGC voltage from A2 becomes more negative, the dc voltage applied to the anode of CR3 also becomes more negative. This results in a greater net charge across C5 which, in effect, reverse-biases CR2. The voltage on the base of Q3 then becomes more negative causing the gain of the RF amplifier to increase. This will increase the output level of the RF Amplifier Assembly and further increase the Oscillator output voltage by the amount required to correct the low-voltage condition sensed at the 745A OUTPUT terminals or at the load. If the AGC level becomes more positive, the net charge across C5 decreases, the conduction of Q3 increases and the 745A output voltage decreases. Overall stability of the AGC circuit is maintained by current source A12A6Q4. Potentiometer A12A6R4 is used to set the nominal AGC level to −1 Vdc at A2TP4.

4-35. The 555 kHz signal controlled by the AGC voltage is coupled through A12A6R8 to the input of the buffer stage. The purpose of the buffer stage is to provide further isolation and to supply the power required to drive the fixed-frequency input of the Modulator. The gain and stability of the buffer stage is maintained by degenerative feedback from the emitter of A12A6Q7 to the emitter of A12A6Q5. The 555 kHz, 0.14 V rms nominal output of the buffer stage is coupled through A12A6C14 to the fixed-frequency input of the Modulator (A12A7).

4-36. Variable Frequency Oscillator (A12A1).

4-37. Refer to the Oscillator Block Diagram (Figure 7-17) and Schematic No. 14 for the following discussion.

4-38. The Variable Frequency Oscillator (VFO) generates a 445 kHz to 545 kHz signal. The VFO frequency is varied by means of the front panel FREQUENCY control. The output of the VFO is coupled to the first Decade Frequency Divider (A12A2) on all frequency ranges. On the X10K FREQUENCY RANGE, the VFO output signal is also applied to the variable-frequency input of the Modulator through the X10K output switch.

4-39. The Variable Frequency Oscillator is a shunt-fed Hartley oscillator with a variable frequency range of 445 kHz to 545 kHz. The VFO frequency is varied by means of variable capacitor C1 (mounted on oscillator main frame) which, in turn, is driven by the front panel FREQUENCY control.

4-40. For normal operation, switching relay A12A1K1 is energized and the VFO resonant frequency is determined by C1, C2 and L1 (on oscillator main frame) and by A12A1C1 and C2. When remote frequency control is selected by the application of circuit ground to A12A1 pin L through the REMOTE PROGRAM connector, K1 opens and relays K2 and K3 close. This places varacter diode CR2 in the tank circuit and removes A12C1, A12C2 and A12A1C1. Capacitance of the varactor, and thus the VFO frequency, can be varied by applying a voltage or resistance to ground to A12A1 pin 9 through the REMOTE PROGRAM connector.

4-41. The 445 kHz to 545 kHz, 1.5 V p-p (nominal) signal at the output of the buffer stage (A12A1Q4 through Q6) is coupled through A12A1C11 to the input of the first Decade Frequency Divider (A12A2) and to the X10K output switch (A12A1Q9 through Q11).

4-42. Oscillation and gain control is maintained by regenerative feedback from the collector of A12A1Q6 through a dual-lobe limiter (CR5, CR6 and Q7) and feedback control amplifier (Q8) to the tank circuit.

4-43. When the X10K FREQUENCY RANGE is selected, the voltage on the cathode of A12A1CR7 (from A13) drops from approximately + 5.2 Vdc to + 0.9 Vdc causing A12A1Q10 and Q9 (which are normally conducting) to cut off. This, in turn, permits the 445 kHz to 545 kHz signal to be coupled through emitter-follower A12A1Q11 to the variable-frequency input of the Modulator (A12A7). When the X10K FREQUENCY RANGE is not selected, the conduction of Q9 reverse-biases the emitter-base junction of Q11 which prevents the signal from being coupled to the Modulator.

4-44. Decade Frequency Dividers (A12A2 through A12A4).

4-45. Refer to Schematic No. 15 for the following discussion. Since the operation of A12A2 through A12A4 is identical, the following circuit description applies to all three assemblies. A portion of the Oscillator Block Diagram appears on Schematic No. 15 to show the overall relationship between the three Decade Frequency Dividers.

4-46. The Decade Frequency Dividers mix the variable frequency input with the 5 MHz signal from A12A5 and divide the resultant sum frequency by a factor of ten. The divided output is coupled to the following Frequency Divider and through the output switch to the Modulator when the corresponding FREQUENCY RANGE is selected.

4-47. The 5 MHz input (pin 15) from A12A5 is applied to the emitter of common-base amplifier Q2 and is coupled to the suppressed-carrier, balanced-mixer consisting of T1, CR1, CR2 and associated circuitry. The variable input frequency (pin 11) from the VFO (on A12A2) or from the preceeding Decade Frequency Divider (on A12A3 and A4) is coupled to the mixer through a limiting and shaping network consisting of R1 and C1. Additional limiting and shaping provided by R2 and C2 (on A12A3 and A4 only) is required due to the difference between the applied signals from the VFO and the preceeding Decade Frequency Divider. This difference can be noted by observing the photographed waveforms appearing on the schematic.

4-48. Transformer T1 in the mixer is adjusted for maximum amplitude of the composite signal at TP1. The sum of the two mixed frequencies is amplified in the tuned amplifier (Q3 through Q5) and is coupled to the 10:1 divider stage. Sum frequencies at the output of the respective A12A2, A3 and A4) tuned amplifiers (TP2) are listed in Table 4-1. Note that the sum frequency upper and lower limits differ by 100 kHz in A12A2, 10 kHz in A12A3 and 1 kHz in A12A4. This means that the tuned amplifier must have a bandpass capability of 100 kHz in A12A2 and 10 kHz and 1 kHz in A12A3 and A4, respectively. For this reason, the adjustment of C11, C14 and C18 in the tuned amplifier stage is much more critical for A12A2 than for A12A3 and A4. On A12A2, the capacitors are adjusted to provide a minimum-required signal amplitude at TP2 for all settings of the front panel FREQUENCY control. On A12A3 and A4, the required bandpass can be obtained by simply adjusting the capacitors for maximum signal amplitude at TP2 without regard to the FREQUENCY control setting.

4-49. Since the tuned amplifier in A12A2 must be stagger-tuned to produce the required 100 kHz bandpass, greater signal amplitude is required at the input of the amplifier. This compensation is provided by the absence of R12 on the A12A2 Assembly.

4-50. The amplified sum frequency at the collector of Q5 is divided by the 10:1 frequency divider IC1. Integrated Circuit IC1 is a high-speed TTL decade counter. The amplitude of the divided signal at the output of IC1 is independent of the signal amplitude at the collector of Q5 since the sum frequency serves only to synchronize the divider.

4-51. The output of the 10:1 divider is coupled through R32 to the succeeding Decade Frequency Divider (on A12A2 and A3 only) and through C23 to the output switch. The operation of the output switch is identical to the operation of the X10K output switch in the VFO (A12A1). The respective outputs of A12A2 (X1K), A12A3 (X100) and A12A4 (X10) are coupled through emitter-follower Q8 and CR6 to the variable-frequency input of the Modulator (A12A7). The Decade Frequency Divider output frequencies are listed in Table 4-1.

4-52. Modulator (A12A7).

4-53. Refer to the Oscillator Block Diagram (Figure 7-17) and Schematic No. 18 for the following discussion.

4-54. The Modulator mixes the variable frequency from A12A1, A2, A3 or A4 with the 555.555 kHz fixed frequency from A12A6, and produces a composite signal which contains the difference between the fixed and variable-frequency inputs. Table 4-2 shows the Modulator input frequencies and the resultant difference frequencies for each of the four frequency ranges.

4-55. The variable-frequency signal (pin 15) from the VFO or Decade Frequency Dividers is coupled through A12A7R2 and C1 to the input of the preamplifier. The signal is amplified by Q3 through Q5 and is transformer-coupled to the class B modulator driver stage (Q6 through Q8, T1 and T2). The gain of the preamplifier is controlled by feedback from the collector of Q7, through C5 and CR2 to the base of Q2. Transistor Q2 controls the conduction of FET Q1 which, in turn, limits the input level at the junction of R2 and C1.

4-56. The variable frequency from the modulator driver and the AGC-controlled 555.555 kHz signal (pin 1) from

Table 4-1. Decade Frequency Dividers

DECADE DIVIDER ASS'Y	VARIABLE FREQUENCY INPUT (kHz)	SUM FREQUENCIES (kHz)	BANDPASS	OUTPUT FREQUENCIES (kHz)
A12A2 (X1K)	445 - 545	5445 - 5545	100 kHz	544.5 - 554.5
A12A3 (X100)	544.5 - 554.5	5544.5 - 5554.5	10 kHz	554.45 - 555.45
A12A4 (X10)	554.45 - 555.45	5554.45 - 5555.45	1 kHz	555.445 - 555.545

Table 4-2. Modulator Frequency Relationships

FREQUENCY RANGE	VARIABLE FREQUENCY INPUT	MODULATOR OUTPUT FREQUENCY (Difference between fixed and variable inputs)
X10K	445 kHz - 545 kHz	10 kHz - 110 kHz
X1K	544.5 kHz - 554.5 kHz	1 kHz - 11 kHz
X100	554.45 kHz - 555.45 kHz	100 Hz - 1.1 kHz
X10	555.445 kHz - 555.545 kHz	10 Hz - 110 Hz

the RF Amplifier are mixed in the balanced diode-ring modulator. The composite signal resulting at TP2 is applied to the input of the Output Amplifier (A12A8).

4-57. The diode-ring modulator circuit is balanced by adjusting A12A7R26, R29 and C14 for minimum ac signal amplitude and 0 Vdc at TP2 with the 5 MHz Oscillator (A12A5) removed. Use of the diode-ring modulator as the final mixer stage results in very low harmonic distortion at the output of the Oscillator.

4-58. Output Amplifier (A12A8).

4-59. Refer to the Oscillator Block Diagram (Figure 7-17) and Schematic No. 19 for the following discussion.

4-60. The purpose of the Output Amplifier is to filter and amplify the 10 Hz to 110 kHz difference frequency from the output of the Modulator. The 2.2 V rms, 10 Hz to 110 kHz signal at the output of the Output Amplifier is coupled out of the Oscillator Assembly, through the Oscillator Output Attenuator to the input of the Preamplifier Assembly (A4).

4-61. The composite signal from the Modulator (A12A7) is applied to A12A8 pin 1 and coupled through the low-pass filter network to the output amplifier stage. The low-pass filter is designed to reject the sum and two original frequencies and pass only the difference frequency. The difference frequency varies from 10 Hz to 110 kHz as a function of the front panel FREQUENCY control and FREQUENCY RANGE pushbuttons. Filter action can be observed by comparing the photographed waveforms at A12A8 pin 1 and A12A8TP1.

4-62. The difference frequency at the output of the filter network is amplified by the output differential amplifier consisting of A12A8Q1 through Q6. Amplifier gain is controlled by negative feedback from the emitter of Q6, through the gain control network (R30, R32 through R34), to the base of Q1B. Gain potentiometer A12A8R32 is adjusted in conjunction with the AGC level potentiometer A12A6R4 (Paragraph 4-34) to produce an input amplitude of 0.1 V rms at A12A8TP1 with the AGC level set to -1 Vdc. The bias potentiometer, A12A8R15, is adjusted for +0.3 Vdc at A12A8TP2. Note that the dc bias voltage at TP2 must be positive. A negative dc voltage at TP2 will cause breakdown of A12A8C16 and further produce a dc offset in the succeeding Preamplifier (A4) and Power Amplifier (A5) stages.

4-63. The 10 Hz to 110 kHz, 2.2 V rms (nominal) signal at the emitter of A12A8Q6 is applied to the rear panel COUNTER OUTPUT connector through emitter-follower A12A8Q7. The signal coupled through A12A8R35 and C16 is applied to the Sampling Amplifier Assembly (A3 – for synchronization) and through the Oscillator Output Attenuator (P/O A10) to the input of the Preamplifier Assembly (A4). Since the dc bias voltage at A12A8TP2 is positive, diode CR2 (in parallel with C16) conducts only when the ac signal swings negative. This serves to protect the electrolytic coupling capacitor (C16) while preserving the dc-blocking feature of capacitive coupling.

4-64. OSCILLATOR OUTPUT ATTENUATOR (P/O A10).

4-65. Refer to the Functional Block Diagram (Figure 7-1) and Schematic No. 13 for the following discussion.

4-66. The 10 Hz to 110 kHz, 2.2 V rms Oscillator output signal is coupled through the network consisting of L2 and C2 (on Mother Board A14) to the Oscillator Output Attenuator. The purpose of L2 and C2 is to compensate for frequency response variations in the Output Amplifier (A12A8). This maintains a relatively uniform signal amplitude throughout the frequency spectrum and thus minimizes the need for AGC correction at high frequencies.

4-67. The Oscillator Output Attenuator is located on the rear-deck switches of the first two voltage-set controls. The purpose of the attenuator is to divide the Oscillator output signal to within approximately 1% of the value required by the Preamplifier (A4) and Power Amplifier (A5) to produce the output voltage selected by the voltage-set controls. Any remaining error is corrected by AGC changes applied to the RF Amplifier (A12A6) in the Oscillator Assembly. This technique permits the Oscillator to operate at essentially a fixed output voltage level, resulting in low distortion and maximum AGC sensitivity.

4-68. PREAMPLIFIER (A4) AND POWER AMPLIFIER (A5).

4-69. Refer to the Functional Block Diagram (Figure 7-1) and Schematic No's. 7 and 8 for the following discussion.

4-70. The Preamplifier input voltage from the Oscillator Output Attenuator varies in amplitude from 0.2 V rms to 2.2 V rms as the voltage-set controls are changed from 0.100000 (10% of range) to 1.099999 (110% of range). The purpose of the Preamplifier is to increase the voltage level of the signal and drive the final voltage amplifier stage which is located on the Power Amplifier Assembly (A5).

4-71. The power amplifier provides the current gain that is required to drive the output transformers and any rated load connected to the OUTPUT terminals. If the Power Amplifier begins to saturate due to an overload condition, the overload detector circuit supplies an overload bias voltage to the Preamplifier to limit the input voltage. The power Amplifier output is coupled through the high

frequency output network or the low frequency output network (part of A4), depending on which FREQUENCY RANGE is selected. Feedback from the high or low frequency output network sets the Preamplifier voltage gain to approximately 15. Voltage gain of the Power Amplifier is slightly less than 1 (Unity).

4-72. Preamplifier.

4-73. The 10 Hz to 110 kHz, 0.2 V rms to 2.2 V rms signal from the Oscillator Output Attenuator is coupled through A4R1 to the base of A4Q2A. The overload protection circuit (A4C1 and Q1) bypasses the input signal to circuit ground if the Power Amplifier supplies overload bias to A4Q1. The preamplifier stage is a high-gain, Darlington differential configuration consisting of A4Q2, Q3, Q6 through Q8 and current source A4Q4. Balance of the differential amplifier is adjusted by means of A4R8 to produce 0 Vdc at the output of the Power Amplifier (measured at A4TP1).

4-74. The signal at the collector of A4Q7 is direct-coupled to the emitter of common-base amplifier A4Q9. Transistors A4Q9 and Q10 provide the necessary drive for the final voltage amplifier A5Q1 which is located on the Power Amplifier Assembly (A5 – Schematic No. 8). The voltage on the collector of A5Q1 varies from 3 V rms to 33 V rms (nominal) as a function of the voltage setting.

4-75. Power Amplifier.

4-76. The power amplifier is basically a complementary-symmetry configuration consisting of input drivers A5Q3 and A5Q4 and wideband output emitter-followers A5Q5 through A5Q10. Power transistors Q5 and Q6 (on the mainframe) in conjunction with A5Q9, current sources A5Q2 and A5Q10, and Zener diodes A5CR5 and A5CR6, function as controlled-voltage sources to maintain a constant emitter-collector voltage across the output emitter-followers. Low-power PNP transistor A5Q9 and high-power NPN transistor Q6 are connected in a "quasi" arrangement to simulate a single, high-power PNP transistor.

4-77. Refer to Figure 4-2 for the following discussion.

4-78. Under quiescent conditions, a relatively small steady-state current is supplied to the Zener diodes by the constant current sources. Due to the bias levels established by the various emitter-base junctions, all of the transistors in the circuit are held in conduction. This results in essentially 0 Vdc at the output of the amplifier. Since the voltage drop across each of the Zener diodes is 5.6 volts, the voltage on the base of the NPN transistor (representing Q5) is + 5.6 volts; and the voltage on the base of the PNP transistor (representing A5Q9 and Q6) is −5.6 volts. The collector voltage supplied to output emitter-followers A5Q5 and A5Q6 is then + 5.6 volts, minus the emitter-base drop across Q5, or + 5.0 volts with respect to the output. Conversely, the voltage on the collectors of A5Q7 and A5Q8 is −5.0 volts with respect to the output. During normal operation, current is always supplied to the Zener

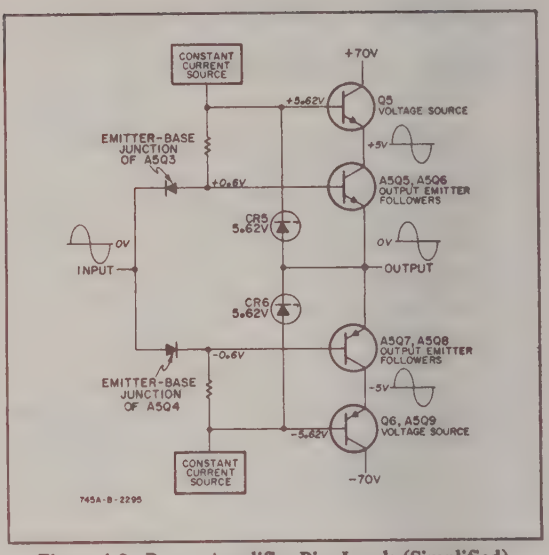


Figure 4-2. Power Amplifier Bias Levels (Simplified)

diodes by the constant current sources. The collectors of the output emitter-followers are, therefore, *always* held at + 5.0 volts with respect to the output voltage. This is illustrated by the typical voltage waveforms shown in Figure 4-2. Note that in the actual power amplifier circuit (Schematic No. 8) the voltage across the output emitter-followers is held at + 4.5 V instead of 5.0 V. This is due to the voltage drops across various resistors that are not shown in the simplified circuits.

4-79. Overall operation of the power amplifier is illustrated in Figure 4-3. Note that the collectors of the input drivers (A5Q3 and A5Q4) are connected to the controlled collector voltage provided by the voltage sources. Due to the bias levels established by the various emitter-base junctions and the constant current provided by the current sources, the input drivers and the controlled voltage sources conduct during both positive and negative alternations of the input signal. The output emitter-followers, however, are cut off during alternate portions of the input cycle. As the input signal swings positive, the base current supplied to A5Q5 and A5Q6 increases producing an increased voltage drop across the emitter-base junctions and the common base-resistor, A5R14. The voltage on the emitters of A5Q7 and A5Q8 then becomes slightly lower than the base voltage provided by the emitter-base drop across A5Q4. This, in turn, causes A5Q7 and A5Q8 to cut off, resulting in class AB operation. Output current for the positive half-cycle is then supplied by the + 70 volt supply through power transistor Q5 and parallel output emitter-followers A5Q5 and A5Q6. Current for the negative half-cycle is supplied by the −70 volt supply through power transistor Q6 and parallel output emitter-followers A5Q7 and A5Q8. Overall stability is maintained by the constant current sources and the main-loop feedback applied to the Preamplifier (A4). Additional thermal stability is provided by emitter resistors A5R16 through A5R19. The output of the Power Ampli-

fier (3 V rms to 33 V rms nominal) is coupled through A5 pin 10 and A4 pin 10 (Schematic No. 7) to the high or low-frequency output network.

4-80. Any overload condition in the power amplifier resulting from an overload at the OUTPUT terminals (or an internal failure) will cause the + 70 V and/or −70 V power supply to current limit. This, in turn, causes A5Q11 and A5Q12 (overload detector) to conduct which removes the reverse bias that is normally applied to the gate of junction FET A4Q1. The resulting conduction of A4Q1 shunts the signal at the input of the preamplifier to circuit ground. When the cause of the overload is removed, the 70 volt power supplies will return to normal and transistors A5Q11 and A5Q12 will cut off. The turn-on bias applied to A4Q1, however, is momentarily retained by the discharge of A5C8 through the parallel resistance of A5R35.

4-81. OUTPUT AND FEEDBACK SWITCHING.

4-82. Refer to the Functional Block Diagram (Figure 7-1) and Schematic No. 7 for the following discussion.

4-83. The 10 Hz to 110 kHz, 3 V rms to 33 V rms signal from the Power Amplifier is coupled through A4 pin 10 to the high or low frequency output network. The purpose of the output networks is to provide feedback stability and minimize the effects of various loads placed at the OUTPUT terminals. On the X1K or X10K FREQUENCY RANGE, relays A4K1 and A4K2 are energized and the signal is coupled through the high frequency output network to the primary of the high frequency step-up transformer T5. Feedback is applied to the base of A4Q2B through the contacts of A4K2. On the X10 or X100 FREQUENCY RANGE, relays A4K1 and K2 are deenergized and A4K3 and K4 are energized. The signal is then coupled through the low frequency output network to the primary of the low frequency step-up transformer T4. Feedback is coupled from the junction of A4R45 and A4R46, through the closed contacts of A4K4 to the base of A4Q2B. Negative feedback from the secondary of T4 is applied to the junction of A4R45 and A4R46 through the network consisting of A4R37 through A4R39. The low frequency balance potentiometer, A4R39, is adjusted to produce equal AGC response on the X100 and X1K frequency ranges.

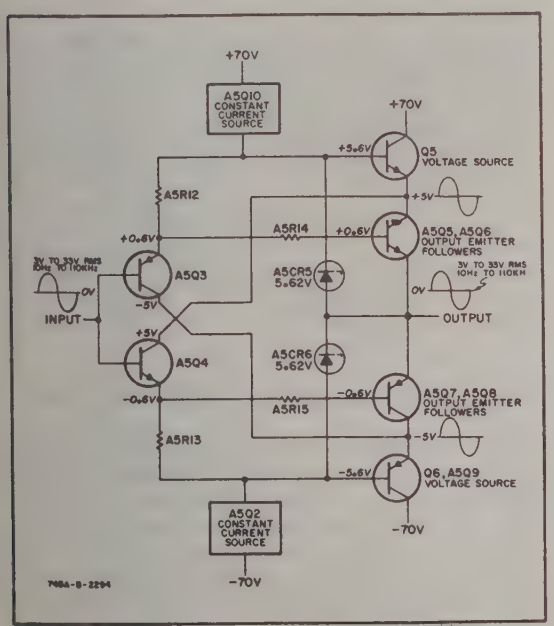


Figure 4-3. Simplified Power Amplifier

4-84. Refer to Figure 7-1 for the following discussion.

4-85. The Power Amplifier drives the high frequency step-up transformer (T5) on the X1K and X10K frequency ranges, and the low frequency step-up transformer (T4) on the X10 and X100 frequency ranges. Step-up transformers T4 and T5 each furnish the 100 V and 10 V outputs for the respective frequency ranges. On the 1 V range and below, the 10 volt output from the secondary of T4 or T5 is applied to the primary of the corresponding step-down transformer T2 or T3. Taps on the secondary of T2 or T3 provide the outputs for the 1 V range and each of the millivolt ranges. Transformer switching is accomplished by means of reed relays on the A6 and A7 Switching Assemblies. The reed relays are actuated in response to commands from the front panel VOLTAGE RANGE pushbuttons.

4-86. Refer to Figure 7-1 for the following discussion.

4-87. The amplitude of the 500 Hz reference square wave at the output of the six-place Reference Divider (P/O A10) varies in amplitude from 0.1 V rms to 1.099999 V rms as a function of the voltage setting. The sine-wave feedback that is compared to this reference must, therefore, be of equal amplitude regardless of the selected VOLTAGE RANGE. On the 1 volt range, the 0.1 V rms to 1.099999 V rms output signal is coupled directly from the HI SENSE terminal (connected to HI OUTPUT) through the contacts of A7K11 to the input of the sampling switch (P/O A3). On the 10 volt and 100 volt ranges, however, the feedback signal from the HI SENSE terminal must be divided by 10 or 100 (respectively) to obtain the required amplitude. On the 10 volt range, the 1.0 V rms to 10.99999 V rms signal from the HI SENSE terminal is coupled through A6K9 (X1K or X10K FREQUENCY RANGE) or A7K12 (X10 or X100 FREQUENCY RANGE) to the primary of the respective high or low frequency step-down transformer, T3 or T2. The signal is divided by a factor of 10 and is coupled through A6R16 and A6K8 (X1K and X10K) or A7K8 (X10 and X100) to the input of the sampling switch. Potentiometer A6R16 is adjusted to produce optimum output voltage accuracy at 10 V, 100 kHz. On the 100 volt range, the 10.0 V rms to 109.9999 V rms signal from the HI SENSE terminal is applied to the 100 V range feedback divider consisting of R3A, R3B, R4, R7 and C9. The signal is divided by 100 and coupled through A7K9 (all frequency

ranges) to the input of the sampling switch. The 100 V range feedback divider is a highly stable, factory selected resistive attenuator. A resistive attenuator is used for the 100 volt range due to the physical-size limitations imposed by comparable inductive dividers. Potentiometer R7 is used to establish the midband accuracy at 100 V, 1 kHz. Variable capacitor C9 is used to adjust the high frequency accuracy at 100 V, 100 kHz.

4-88. On the 1 mV, 10 mV and 100 mV ranges, the signal amplitude at the HI SENSE terminal is below the level required by the AGC circuitry. For this reason, feedback is coupled from the 1-volt tap on the secondary of T3 (X1K or X10K FREQUENCY RANGE) or T2 (X10 or X100 FREQUENCY RANGE) through A6K7 or A7K7 to the input of the sampling switch. Output voltage accuracy at high frequencies is further controlled by negative feedback from pin 4 of T3 coupled through A6C1 and A6C2. These capacitors are selected at the factory to produce optimum voltage accuracy at 100 mV, 100 kHz. Since the millivolt-range feedback is taken from the 1-volt tap on the output transformers, the AGC circuitry will only compensate for voltage errors that are present on the 1-volt tap. The output voltage accuracy on the millivolt ranges is, therefore, dependent on the accuracy of the secondary windings of the respective output transformers.

4-89. REFERENCE SQUARE-WAVE GENERATOR (A1).

4-90. Refer to Schematic No's. 1 through 4 for the following discussion.

4-91. The Reference Square-Wave Generator produces a precision, 19.8 V p-p, 500 Hz square wave which is divided and used to establish the output voltage accuracy of the Model 745A.

4-92 ± 15 Volt Power Supply (A1A1, Schematic No. 1).

4-93. The +15 V and -15 V Power Supplies furnish pre-regulated voltages to the 19.8 V Square-Wave Generator (A1A3) and to the various other assemblies throughout the instrument. Each supply consists of a series regulator, current limit detector and control amplifier. Stability of the -15 V supply is controlled by a -6 Vdc reference voltage developed in the Reference Oven Assembly (A1A2). The +15 V supply is referenced to the -15 V supply.

4-94. 19.8 V Square-Wave Generator (A1A3, Schematic No. 3).

4-95. The 19.8 V Square-Wave Generator provides additional regulation to the +15 Vdc and -15 Vdc inputs from A1A1, resulting in highly stable +9.9 Vdc and -9.9 Vdc reference voltages which are applied to the +9.9 V and -9.9 V switching circuits. The +9.9 V and -9.9 V switching circuits are gated alternately by a 500 Hz square wave from the Switch-Drive Generator (P/O A1A4).

4-96. The reference feedback divider sets the exact value of the +9.9 V and -9.9 V supplies. During calibration, the 500 Hz square wave is disabled (by A1A4S1) and the +9.9 V and -9.9 V can be measured individually at A1A3TP5.

4-97. Since the operation of the +9.9 V and -9.9 V switching circuits is identical (except for polarities), the following discussion applies to both circuits.

4-98. When the 500 Hz square wave from A1A4 switches negative, the +9.9 V switching transistor (A1A3Q6) is gated-on and A1A3Q5 is cut off. The accuracy of the +9.9 V at A1A3TP5 is then controlled by one half of the reference feedback divider which provides feedback to the +9.9 V differential control amplifier, A1A2Q5. This feedback loop is referred to as the "outside loop".

4-99. When the switching square wave becomes positive, A1A3Q6 is cut off and A1A3Q5 is gated-on. Since the +9.9 V supply is now essentially removed from the reference feedback divider, feedback for the +9.9 V supply is controlled by the conduction of A1A3Q5. This feedback path is referred to as the "inside loop".

4-100. Potentiometers A1A3R9 (+9.9 V) and A1A3R26 (-9.9 V) are used to adjust the "inside loop" feedback to produce voltages at TP3 and TP4 (respectively) that are approximately 40 mV below the voltages produced by the "outside loop" feedback. These adjustments are performed at the factory to produce optimum accuracy and symmetry of the 500 Hz reference square wave. Further adjustment is not normally required unless A1A3 has been repaired or replaced.

4-101. When the X1 ERROR RANGE is selected, relays A1A4K1 and K2 (error measurement network) are deenergized. The reference bias applied to the +9.9 V differential amplifier (A1A2Q5A) can then be varied ± 6% by means of the ERROR MEASUREMENT control, R1 (on the main frame). When the X.1 ERROR RANGE is selected, relay A1A4K1 is energized and the +9.9 V reference bias can be varied by ± 0.6%. The ± 6% and ± 0.6% variations introduced by the ERROR MEASUREMENT control cause the total rms amplitude of the reference square wave to vary by ± 3% and ± 0.3% (respectively). When the 0 ERROR RANGE is selected, both relays are energized and the ERROR MEASUREMENT control does not affect the accuracy of the reference square wave.

4-102. Switch-Drive Generator (A1A4, Schematic No. 4).

4-103. The Astable and Bistable multivibrators in A1A4 produce the 500 Hz square wave used to gate the +9.9 V and -9.9 V switches in A1A3. The Astable multivibrator (A1A4Q1 and Q2) generates a 1000 Hz non-symmetric square wave. The Bistable multivibrator (A1A4Q3 and Q4) divides the 1000 Hz signal by two and produces a very symmetric square wave which is coupled through the buffer stage (A1A4Q5) to A1A3.

4-104. Reference Oven Assembly (A1A2, Schematic No. 2).

4-105. The Reference Oven Assembly contains the -6 Vdc reference supply and the differential control amplifiers for the -15 V, -9.9 V and +9.9 V power supplies. The oven temperature is maintained at 82°C by the temperature sensing bridge (A1A2A1Q1 and Q2). When the temperature drops below 82°C, the bridge produces a positive-going voltage which increases the conduction of the oven heater amplifier (P/O A1A4) causing the oven heater to increase in temperature. Conversely, when the temperature exceeds 82°C, conduction of the oven heater amplifier decreases.

4-106. The -6 Vdc reference supply (A1A2A1CR1, and R7 through R10) produces a highly stable reference voltage that is used to control the other regulated supplies in the Reference Square-Wave Generator. The -6 V reference supply is regulated by a pre-aged Zener diode (CR1), selected for excellent long-term stability characteristics. The constant temperature environment within the Oven Assembly allows the -6 Vdc reference voltage to be almost completely unaffected by ambient temperature variations.

4-107. REFERENCE DIVIDER (A10).

4-108. Refer to the Functional Block Diagram (Figure 7-1) and Schematic No. 13 for the following discussion.

4-109. The 9.9 V rms, 500 Hz reference square wave is coupled through C1 and the shaping network consisting of L1 and R6 to the 9:1 divider transformer, T1. The square wave is then divided by T1 resulting in a 1.1 V rms square wave at the input of the Reference Divider.

4-110. The Reference Divider consists of six magnetic dividers operated by the front panel voltage-set controls. The output of the Reference Divider is a 500 Hz square wave which varies in amplitude from 0.100000 V rms to 1.099999 V rms as the voltage-set controls are changed from 10% to 110% of the selected VOLTAGE RANGE.

4-111. SAMPLING AMPLIFIER (A3).

4-112. Refer to the Functional Block Diagram (Figure 7-1) and Schematic No. 6 for the following discussion.

4-113. The 500 Hz, 0.1 V rms to 1.1 V rms square wave from the Reference Divider and the 10 Hz to 110 kHz, 0.1 V rms to 1.1 V rms sine-wave feedback from the Switching Assemblies (A6 and A7) are applied to the sampling switch consisting of A3Q11 through A3Q14. Junction FET's A3Q11 and A3Q14 are gated on and off at a 1 Hz (X10 FREQUENCY RANGE) or 2 Hz rate, alternately passing the reference square wave and the sine-wave feedback to the sampling amplifier. The output of the sampling amplifier is coupled through the Thermocouple Driver Gain Control (P/O A10) to the input of the Error Amplifier Assembly.

4-114. Sample-Gate Generation.

4-115. The sample gate which controls the sampling switch is produced by the sample-rate reference oscillator (A3Q7 and A3Q8) in conjunction with the sample-gate generator (A3Q9 and A3Q10) and the sample-gate synchronizer (A3Q4 through A3Q6). The sample-rate reference oscillator generates a 2 Hz (X10 FREQUENCY RANGE) or 4 Hz sawtooth waveform which is used to trigger the bistable sample-gate generator. The frequency of the reference oscillator is determined primarily by the RC time constant of A3C5, R10 and R12. When the X10 FREQUENCY RANGE is selected, relay A3K1 is energized. This places A3C6 in parallel with A3C5 which reduces the reference oscillator frequency to 2 Hz, and the resulting sample gate to 1 Hz. The output of the sample-gate generator is a 1 Hz or 2 Hz square wave which is applied to the bistable sample-gate synchronizer through limiting resistors A3R13 and A3R14.

4-116. A 2.2 V rms sine wave from the Oscillator (representing the 745A output frequency) is applied to the axis-crossing detector (A3Q1A and A3Q1B). The output of the axis-crossing detector causes the Schmitt trigger (A3Q2 and Q3) to fire each time the sine wave crosses through zero in a positive direction. The Schmitt trigger output triggers the sample-gate synchronizer each time the sample-gate generator changes state. This prevents the sampling switch from changing state at different points on the sine wave which would produce an rms error when the sine wave is applied to the error detector (P/O A2).

4-117. The output of the sample-gate generator is a 30 V p-p, 1 Hz (X10 FREQUENCY RANGE) or 2 Hz square wave. The sample gate is applied to switching transistors A3Q12 and A3Q13 and is also coupled through A3 pin 12 to the synchronous demodulator on the Error Amplifier Assembly (A2). Potentiometer A3R10 in the reference oscillator circuit is used to adjust the frequency of the sample gate to 2 Hz.

4-118. Sampling Switch.

4-119. As the sample gate switches positive, A3Q12 is gated on and A3Q13 is cut off. The resulting conduction of A3Q12 removes the 15 V reverse bias that is applied to the gate of A3Q11 through A3R16. The reference square wave is then coupled through A3Q11 to the input of the sampling amplifier. Conversely, when the sample gate switches negative, A3Q12 is cut off, A3Q13 is gated on and the sine-wave feedback is coupled through A3Q14 to the input of the sampling amplifier. A high input impedance is maintained within the sampling switch by the bootstrapping effect of positive feedback from the junction of A3R50 and A3R51 to the emitters of A3Q12 and A3Q13.

4-120. Sampling Amplifier.

4-121. The sampling amplifier consists of a Darlington differential amplifier (A3Q15 through A3Q19), driver amplifiers A3Q20 and A3Q21, and complementary output

emitter-followers, A3Q22 and A3Q23. Transistor A3Q15 is a dual field-effect transistor (FET) which produces a minimum loading effect on the sampled signals. The gain of the sampling amplifier (approximately 6) is controlled by feedback from the junction of A3R48 and A3R49 to the gate of A3Q15B. Potentiometer A3R34 is used to adjust the balance of the differential amplifier to produce a nominal bias level of 0 Vdc at A3TP1. The high frequency response of the sampling amplifier is controlled by the network consisting of A3C11, C12 and R38. Variable capacitor A3C12 is adjusted for optimum output voltage accuracy with the 745A set to 1 V, 100 kHz.

4-122. The output of the sampling amplifier is composed of the alternate sine-wave/square-wave samples which vary in amplitude from 0.66 V rms to 6.6 V rms as a function of the voltage setting. These sampled signals are coupled through A3R47 and the Thermocouple Driver Gain Control (P/O A10) to the input of the Error Amplifier Assembly (A2).

4-123. THERMOCOUPLE DRIVER GAIN CONTROL (P/O A10).

4-124. Refer to the Functional Block Diagram (Figure 7-1) and Schematic No. 5 for the following discussion.

4-125. The Thermocouple Driver Gain Control functions as a variable input resistance for the operational amplifier that is used to drive the error-detector thermocouple on the Error Amplifier Assembly (A2). The sine-wave/square-wave sample at the output of the sampling amplifier (P/O A3) varies from 0.66 V rms to 6.6 V rms as the voltage-set controls are changed from 10% of range to 110% of range. The resistance of the Thermocouple Driver Gain Control is varied by the first two voltage-set controls. As the voltage setting is increased, the resistance of the Gain Control increases proportionally to reduce the closed-loop gain of the thermocouple driver amplifier. This results in an essentially fixed level of 1.5 V rms applied to the thermocouple regardless of the voltage setting.

4-126. ERROR AMPLIFIER (A2).

4-127. Refer to the Functional Block Diagram (Figure 7-1) and Schematic No. 5 for the following discussion.

4-128. The Error Amplifier consists of a thermocouple driver (A2Q1 through A2Q7), an error-detector thermocouple (A2TC1), an error amplifier (A2Q8 through A2Q18), a synchronous demodulator (A2Q19 through A2Q22) and an integrator amplifier (A2Q23 through A2Q28).

4-129. The sine-wave/square-wave sample from A3 is coupled through the Thermocouple Driver Gain Control to the thermocouple driver. The thermocouple driver serves as a variable gain operational amplifier to drive the error-detector thermocouple. The error-detector thermocouple produces a nominal −7 mVdc output. Any rms difference or "error" between the sine-wave feedback and the square-wave reference produces small changes in the thermocouple output each time the sampling switch changes state. The thermocouple output is amplified by the error amplifier. The stages in the error amplifier are capacitively coupled to block the dc component and pass only the 1 Hz or 2 Hz error signals. The synchronous demodulator detects the amplitude and relative phase of these error signals and produces a pulsating dc output which is filtered by the integrator amplifier and applied to the Oscillator (A12) as an AGC voltage.

4-130. Thermocouple Driver.

4-131. The 0.6 V rms to 6.6 V rms sine-wave/square-wave sample from the sampling amplifier (P/O A3) is coupled through the Thermocouple Driver Gain Control to the thermocouple driver. The thermocouple driver is a variable gain operational amplifier consisting of an input differential amplifier, A2Q1 through A2Q3, driver amplifiers A2Q4 and A2Q5, and complementary emitter-followers, A2Q6 and A2Q7. Potentiometer A2R9 is used to balance the input differential amplifier to produce a nominal bias level of 0 Vdc at A2TP1. Resistor A2R21, which is connected in parallel with the 90 ohm heater of A2TC1, provides compensation for minor response variations that occur at low frequencies.

4-132. The closed-loop gain of the thermocouple driver is determined primarily by the negative feedback from the junction of A2TC1 and A2R23, through A2R22 to the base of A2Q1A, and the variable input resistance provided by the Thermocouple Driver Gain Control. As the voltage setting is increased, the resistance of the Thermocouple Driver Gain Control also increases causing the gain of the thermocouple driver to decrease. The closed-loop gain of the thermocouple driver (from the output of A3) varies from approximately 2.5 to 0.24 as the voltage-set controls are varied from 10% of range to 110% of range. The sine-wave/square-wave sample applied to the heater of A2TC1, therefore, remains at an essentially fixed level of 1.5 V rms regardless of the voltage setting.

4-133. Error-Detector Thermocouple.

4-134. The error-detector thermocouple (A2TC1) produces an average output voltage of −7 mVdc. If the rms value of the sine-wave feedback differs from that of the square-wave reference, the thermocouple output voltage will change each time the sampling switch changes state. These changes, therefore, occur at a 1 Hz (X10 FREQUENCY RANGE) or 2 Hz rate, in step with the sample gate, and are superimposed on the nominal −7 mVdc output of the thermocouple. If the sine-wave feedback and the square-wave reference have identical rms values, the thermocouple output will remain constant.

4-135. A difference or "error" of 0.01% between the sine-wave feedback and the reference square wave will produce a change of approximately 1.4 μV at the output of the thermocouple. For example, if the rms value of the sine wave is 0.01% greater than the rms value of the square

wave, the thermocouple output voltage will become 1.4 μV more negative when the sine wave is sampled. If a continuous error of 0.01% exists, the thermocouple output will then resemble a 1.4 μV p-p, 1 Hz or 2 Hz square wave. The amplitude of this square wave or "error signal" is determined by the magnitude of the error (0.01%), while the relative phase is determined by which of the sampled signals is greater in amplitude.

4-136. Error Amplifier.

4-137. The output of the thermocouple is direct-coupled to the first error amplifier stage consisting of A2Q8 through A2Q12. Due to the extremely low-level error signals and the overall sensitivity of the AGC circuit, a high degree of stability is required in this first error amplifier stage. The required stability is maintained by current sources A2Q11 and A2Q12 in conjunction with A2Q10 and the Zener-regulated supply voltages provided by A2CR4 and A2CR7. Additional stability is provided by the use of dual transistors A2Q8 and A2Q9 which are factory selected for minimum noise. Balance potentiometer A2R34 is adjusted to produce a nominal bias level of + 0.6 Vdc at A2TP2. The overall gain of this differential amplifier stage is approximately 30. If the rms value of the sine-wave feedback differs from that of the square-wave reference by 0.01%, the thermocouple output voltage will change by approximately 1.4 μV each time the sampling switch changes state. An error of 0.01% will, therefore, produce a variation of 0.042 mV at A2TP2. Note, however, that a phase inversion occurs in the differential amplifier causing the error signal at A2TP2 to be 180 degrees out of phase with the error signal introduced on the base of A2Q8A.

4-138. The 1 Hz or 2 Hz error signal appearing on the collector of A2Q9B is coupled through A2C7 to the base of A2Q13A. The differential amplifier consisting of A2Q13 and A2Q14 provides a fixed gain of 10. Gain control feedback from the emitter of Q14 is divided by the network consisting of A2R42, R45 and C8 and applied to the base of A2Q13B. Error signals on the emitter of A2Q14 are coupled through A2C9 to the base of A2Q15. The final error amplifier stage consisting of A2Q15 through A2Q17 provides an additional gain of 10 which is controlled by feedback from the collector of A2Q17, through A2R47 to the base of A2Q15. Note that the error signal on the collector of A2Q17 is 180 degrees out of phase with the signal coupled to the base of A2Q15. Since a phase inversion also occurs in the first error amplifier stage, the error signal on the collector of A2Q17 is in phase with the variation at the output of the thermocouple. The signal on the collector of A2Q17 is divided by 10 by the network consisting of A2R51, R52 and CR8 and is direct-coupled to the base of A2Q18. The gain provided by A2Q18 is approximately 10. The error signals appearing on the collectors of A2Q17 and A2Q18 are, therefore, approximately equal in amplitude and 180 degrees out of phase.

4-139. Synchronous Demodulator.

4-140. The synchronous demodulator is composed of four junction field-effect transistors (FET's), A2Q19 through A2Q22. Since these are junction FET's, they are normally conducting until they are reverse-biased by the 30 V p-p sample gate applied to the junction of switching diodes A2CR9 through A2CR12. As the sample gate switches positive applying the square-wave reference to the thermocouple, A2Q19 and A2Q22 are cut off. Any variation on the collector of A2Q18 is then coupled through A2C10 and A2Q21 to the input of the integrator amplifier. Since A2Q22 is cut off and A2Q20 is conducting, capacitor A2C11 will charge or discharge (depending on the phase of the error signal) through A2Q20. Conversely, when the sample gate switches negative applying the sine-wave feedback to the thermocouple, A2Q20 and A2Q21 are cut off. The variation on the collector of A2Q17 will then be coupled through A2C11 and A2Q22 to the input of the integrator amplifier. Capacitor A2C10 will, in turn, charge or discharge through A2Q19.

4-141. Overall operation of the synchronous demodulator is illustrated by the relative input and output wave forms shown in Figures 4-4 and 4-5. The waveform photographs were taken with no sine-wave feedback applied to the thermocouple which results in a continuous error of sufficient magnitude to observe on an oscilloscope. As the sample gate switches negative applying the 0 V rms sine-wave feedback to the thermocouple, a corresponding negative variation is introduced on the base of A2Q17 (Figure 4-4, point A). The resulting positive variation on the collector of A2Q17 is coupled through A2C11 and A2Q22 to the input of the integrator amplifier (Figure 4-5, Point A). Note that a positive variation at the input of the integrator amplifier will cause the AGC voltage to become more negative and increase the oscillator output voltage. As the sample gate switches positive, the square-wave reference applied to the thermocouple produces a positive change on

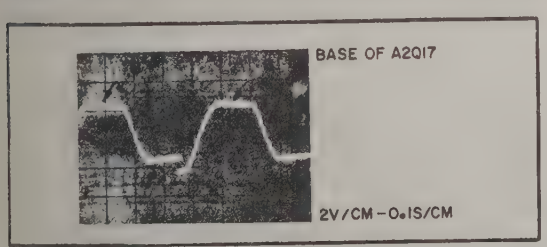


Figure 4-4. Synchronous Demodulator Input

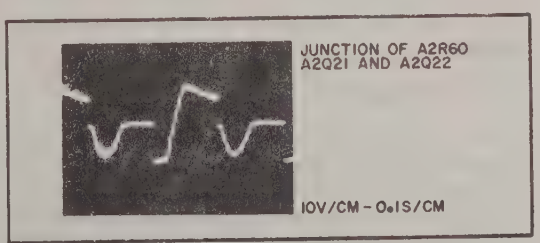


Figure 4-5. Synchronous Demodulator Output

the base of A2Q17 (Figure 4-4, Point B). The resulting negative variation on the collector of A2Q17 causes A2C11 to discharge through A2Q20. The positive variation on the collector of A2Q18, however, is coupled through A2C10 and A2Q21 to the input of the integrator amplifier (Figure 4-5, Point B). The input to the integrator amplifier is, therefore, a pulsating dc, the polarity of which is determined by the phase of the error signal. The amplitude of the pulsating dc is determined by the magnitude of the error.

4-142. Integrator Amplifier.

4-143. The integrator amplifier consists of a high-gain input differential amplifier A2Q23 through A2Q26, an inverting amplifier A2Q27, and an output emitter-follower A2Q28. The purpose of the integrator amplifier is to filter the pulsating dc from the synchronous demodulator and develop an AGC voltage which is applied to the RF Amplifier (A12A6) in the Oscillator section. Gain and response of the integrator amplifier is determined by the overall negative feedback from the emitter of Q28, through A2C12 to the base of A2Q23A in conjunction with the input resistance provided by A2R60.

4-144. When the X10 FREQUENCY RANGE is selected, relay A2K1 is energized placing A2C13 in parallel with A2C12. This increases the overall response time of the integrator amplifier to compensate for the reduced sample rate. Diodes A2CR14 and A2CR15 prevent the electrolytic feedback capacitors from charging in the reverse direction. Balance potentiometer A2R67 in the input differential amplifier is adjusted to produce a nominal bias level of 0 Vdc at A2TP3.

4-145. The output of the integrator amplifier (-1 Vdc nominal) is applied to the RF Amplifier (Paragraph 4-34) in the Oscillator and also to the Front Panel Switching Logic Assembly (A13) for use in the overload indicator circuit. If the rms value of the sine-wave feedback is less than the rms value of the square-wave reference, the integrator output voltage will become more negative, causing the oscillator output voltage to increase. If the rms value of the sine-wave feedback is greater than that of the square-wave reference, the integrator output voltage will become more positive, causing the oscillator output voltage to decrease.

4-146. FRONT PANEL SWITCHING LOGIC (A13).

4-147. Refer to Schematic No. 20 for the following discussion.

4-148. Switching Circuits.

4-149. The Front Panel Switching Logic Assembly contains a separate switching circuit for each of the front panel pushbuttons and a control circuit for the front panel OVERLOAD lamp. Whenever a front panel pushbutton is pressed, the corresponding switching circuit is biased into conduction and the remaining switching circuits in that particular group are cut off. The cut-off action is caused by the increased drop across the common emitter-resistor (R1, R19 and R26).

4-150. When power is initially applied to the instrument, the 1 mV (VOLTAGE RANGE), 0 (ERROR RANGE), and X1K (FREQUENCY RANGE) switching circuits are biased-on by Zener diodes CR2, CR10, and CR16, respectively. LOCAL SENSE is also selected at turn-on due to a positive dc level (From A7) which is applied to the base of A13Q32 when any of the millivolt ranges are selected.

4-151. Depressing any of the front panel pushbuttons energizes the associated switching circuit by applying a virtual ground to the base of one of the switching transistors. These ground closures can also be applied to the switching circuits through the rear panel REMOTE PROGRAM connector (J23). Remote programming methods are discussed in Section III.

4-152. Each switching circuit (except SENSE) is connected through a control line to diode-transistor logic circuits in other parts of the instrument. When a switching circuit is actuated, the voltage on the control line drops from +5.2 Vdc to approximately +0.9 Vdc. This causes the corresponding pushbutton lamp to illuminate and further provides a "true" command to the associated diode-transistor logic circuitry.

4-153. The VOLTAGE RANGE switching circuits are connected directly to the voltage range and feedback switching circuits on the A6 and A7 Switching Assemblies (Schematic No's. 9 and 10). The ERROR RANGE switching circuits are connected to logic circuits on the A6 Assembly, which, in turn, control the error range switching relays on the Oven Control and Switch Drive Generator Assembly (A1A4). The FREQUENCY RANGE switching circuits are connected to the X10 through X10K output switches in the Oscillator Assembly and also to the A6 and A7 Switching Assemblies to enable the voltage range and feedback switching circuits when the respective high frequency ranges (X1K and X10K) or low frequency ranges (X10 and X100) are selected.

4-154. The SENSE switching circuit is simply a bistable multivibrator that is used to control the two switching relays, A13K1 and A13K2. When LOCAL SENSE is selected, relays A13K1 and A13K2 are energized. This connects the HI OUTPUT terminal to the HI SENSE terminal, and the LO OUTPUT terminal to the LO SENSE terminal.

4-155. When any of the millivolt ranges are selected, a positive bias level is applied through A13R40 and CR18 to the base of A13Q32 to prevent REMOTE SENSE from being selected. In addition, LOCAL SENSE is automatically selected on the 1000 V EXT. VOLTAGE RANGE. This is accomplished by A13Q34 which has been added to the instrument since the introduction of the Model 746A High Voltage Amplifier. Refer to Appendix C for further information concerning this addition.

4-156. Overload Indicator.

4-157. The AGC voltage from the Error Amplifier Assembly (A2) is applied through A13 pins 5 and 20 to the overload-indicator circuitry (A13Q15 through A13Q17). Transistor A13Q15 is normally conducting due to the forward bias established by A13R16 and A13R18. If the AGC voltage at the junction of R18 and the base of Q17 becomes more negative than -3 Vdc, A13Q15 will cut off. This permits A13Q16 to conduct causing the front panel OVERLOAD lamp (DS1) to illuminate. If the AGC voltage becomes positive (+ 0.2 Vdc), A13Q17 is biased into conduction which also causes the OVERLOAD lamp to illuminate.

Wherever the recommended instruments are listed for testing, checking, and calibrating, replace with the equivalent standards as listed in Table 5-1.

Table 5-1. Required Test Equipment

INSTRUMENT TYPE	MODEL NUMBER
Electronic Counter	S-D 1037M
Distortion Analyzer	H-P 334
AC Differential Voltmeter	J-F 887
DC Differential Voltmeter	J-F 887
Variable Line Transformer	W10MT3A
AC Divider Transformer	GER 1000
AC Amplifier	BAL 310A
DC Voltage Standard	J-F 332
Digital Voltmeter	Dana 5703
AC Voltmeter	H-P 400H
Oscilloscope	TEK 561
Resistor	Standard, Carbon

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains complete maintenance information for the Model 745A AC Calibrator. Included are performance checks, adjustment procedures, troubleshooting techniques, and instructions for the removal and replacement of various assemblies and components.

5-3. REQUIRED TEST EQUIPMENT.

5-4. The test equipment required for maintaining the Model 745A is listed in Table 5-1. If the recommended model is not available, any instrument that has specifications equal to or better than the required specifications can be used.

5-5. PERFORMANCE CHECKS.

5-6. The following performance checks are in-cabinet procedures that can be used to verify that the Model 745A is operating within the specifications listed in Table 1-1. These procedures can be used for incoming quality control inspection, to check specifications after a repair or for routine maintenance. The italicized final step of each procedure will prescribe the corrective action to be taken if the instrument fails to meet the required specifications.

5-7. TEST CARD.

5-8. A Performance Check Test Card is provided at the end of this section for your convenience in recording the performance of the Model 745A during performance checks This card can be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance check. The test card may be reproduced without written permission from Hewlett-Packard.

5-9. FREQUENCY ACCURACY CHECK.

5-10. The purpose of this check is to verify the accuracy of the Model 745A output frequency as indicated on the FREQUENCY scale.

SPECIFICATION:

± (2% of setting within temperature range of 20°C to 30°C)

Temperature Coefficient:*

± (0.05% of end scale per °C from + 4°C to 20°C and from 30°C to 40°C)

* Derate frequency accuracy specification by this temperature coefficient for operation in temperature ranges of +4°C to 20°C and from 30°C to 40°C.

REQUIRED TEST EQUIPMENT:

Electronic Counter (-hp- Model 5216A)

a. Connect the input of the electronic counter to the 745A rear panel COUNTER OUTPUT connector.

b. Set the 745A FREQUENCY vernier and FREQUENCY RANGE pushbuttons to each frequency listed in Table 5-2. At each frequency setting,

Table 5-2. Frequency Accuracy Check

NOTE

The tolerances listed in this table are based on the frequency accuracy specification of: ± (2% of setting within temperature range of 20°C to 30°C).

745A FREQUENCY SETTING	FREQUENCY RANGE	TOLERANCES
10 Hz	X10*	9.8 Hz - 10.2 Hz
20 Hz		19.6 Hz - 20.4 Hz
30 Hz		29.4 Hz - 30.6 Hz
50 Hz		49.0 Hz - 51.0 Hz
70 Hz		68.6 Hz - 71.4 Hz
100 Hz		98.0 Hz - 102.0 Hz
100 Hz	X100	98.0 Hz - 102.0 Hz
200 Hz		196 Hz - 204 Hz
300 Hz		294 Hz - 306 Hz
500 Hz		490 Hz - 510 Hz
700 Hz		686 Hz - 714 Hz
1 kHz		980 Hz - 1020 Hz
1 kHz	X1K	980 Hz - 1020 Hz
2 kHz		1960 Hz - 2040 Hz
3 kHz		2940 Hz - 3060 Hz
5 kHz		4900 Hz - 5100 Hz
7 kHz		6860 Hz - 7140 Hz
10 kHz		9.8 kHz - 10.2 kHz
10 kHz	X10K	9.8 kHz - 10.2 kHz
20 kHz		19.6 kHz - 20.4 kHz
30 kHz		29.4 kHz - 30.6 kHz
50 kHz		49.0 kHz - 51.0 kHz
70 kHz		68.6 kHz - 71.4 kHz
100 kHz		98.0 kHz - 102 kHz

* Use a 10 second sample period to measure frequency on X10 FREQUENCY RANGE.

observe the electronic counter reading and verify that the 745A output frequency is within the tolerances listed in the table.

NOTE

To accurately measure the 745A output frequency on the X10 FREQUENCY RANGE, set the electronic counter for a 10 second (or longer) sample period.

c. If any of the 745A frequency settings are not within the specified tolerances, refer to the Frequency Scale Tracking Adjustment procedure (Paragraph 5-80).

5-11. DISTORTION CHECKS.

5-12. The purpose of the distortion checks is to measure the total harmonic distortion and noise that is present on the output of the 745A. On the 100 mV through 100 V ranges, this check can be performed using a distortion analyzer to facilitate a broadband noise and distortion measurement. On the 1 mV and 10 mV ranges, the 745A output voltage is below the minimum input level requirements of the distortion analyzer. Broadband measurements using an amplifier to increase the voltage level are largely inaccurate due to the noise and distortion introduced by the amplifier. For this reason, a wave analyzer with at least 50 dB of dynamic range (for an input of 1 mV) is required for the 1 mV and 10 mV Distortion Checks (Paragraph 5-16).

5-13. Since the 745A output is transformer coupled, the internal voltage range switching is accomplished by selecting the appropriate tap on the secondary of the high or low frequency output transformer. This permits the oscillator and power amplifier to maintain the same operating level regardless of the selected VOLTAGE RANGE. The 1 mV through 1 V outputs are tapped from the same secondary winding; and any distortion or noise that is present on the 1 mV and 10 mV ranges can normally be detected on the 100 mV and 1 V ranges. If the 745A output distortion and noise is within specifications on the 100 mV through 100 V ranges, the 1 mV and 10 mV distortion checks may be omitted at the discretion of the user.

5-14. Distortion and Noise Check 100 mV - 100 V Ranges.

NOTE

Distortion measurements on the 745A 100 mV range require less than 75 dB (with respect to + 2 dB) of distortion and noise introduced by the distortion analyzer. Before proceeding with the 100 mV distortion check, verify that the distortion analyzer meets this requirement. If the distortion analyzer cannot be used, the 100 mV distortion (20 Hz to 110 kHz) can be measured using the procedure outlined in Paragraph 5-16 for the 1 mV and 10 mV Range Distortion Check.

5-15. The purpose of this check is to measure the total harmonic distortion or noise that is present on the output of the 745A.

SPECIFICATION:

± (0.05% of setting + 10 μV over 100 kHz bandwidth)

REQUIRED TEST EQUIPMENT:

Distortion Analyzer (-hp- Model 333A/334A)

Load Resistors:
- 100 mV Range: 3.01 kilohm ± 1% 1/8 W (-hp- 0757-0273)
- 1 V Range: 22.1 ohm ± 1% 1/4 W (-hp- 0757-0497)
- 10 V Range: 221 ohm ± 1% 1/2 W (-hp- 0757-0805)
- 100 V Range: 2 kilohm ± 5% 5 W (-hp- 0812-0100)

a. Connect the 745A OUTPUT to the input of the distortion analyzer.

b. Set the distortion analyzer controls as follows:

FUNCTION	SET LEVEL
METER RANGE	0.3 V (0 dB)
SENSITIVITY	MIN
MODE	MANUAL
FREQUENCY	10 Hz

For distortion measurements on the 745A 100 mV range, set the distortion analyzer SENSITIVITY to MAX and use the 0.1 V (−10 dB) METER RANGE as the 100% reference setting. The next lower range (0.03 V) then becomes the 30% range, etc.

c. Set the 745A controls as follows:

VOLTAGE RANGE	100 mV
Voltage Setting	100.0000 mV
FREQUENCY RANGE	X10
FREQUENCY Scale	1.0 (10 Hz)
ERROR RANGE	0
SENSE	LOCAL

d. Connect the appropriate 100 mV, 1 V, 10 V or 100 V load resistor across the 745A OUTPUT terminals at the 745A front panel. (Correct load resistors are listed at the beginning of this procedure.)

e. Adjust the distortion analyzer SENSITIVITY controls for a 100% set level reference.

f. Set the distortion analyzer FUNCTION to DISTORTION and adjust the FREQUENCY and

BALANCE controls for maximum null on the meter of the distortion analyzer.

g. Set the distortion analyzer MODE to AUTO and reduce METER RANGE as necessary to obtain an on-scale meter reading.

h. Observe the distortion analyzer meter reading and calculate the 745A total harmonic distortion and noise (in percent).

i. The 745A total harmonic distortion and noise should be within the tolerances listed in Table 5-3.

j. Set the distortion analyzer METER RANGE to the 100% reference setting and FUNCTION to SET LEVEL.

k. Repeat Steps e through j with the 745A and distortion analyzer set to each of the following frequencies: 50 Hz, 100 Hz, 1 kHz, 10 kHz, 50 kHz and 100 kHz. At each frequency setting, the 745A total harmonic distortion and noise should be within the tolerances listed in Table 5-3.

l. Repeat Steps b through k with the 745A set to 100% of VOLTAGE RANGE on the 1 V, 10 V and 100 V ranges.

m. If the 745A fails to meet any of the distortion specifications, refer to Paragraph 5-64.

Table 5-3. Distortion and Noise Check (100 mV through 100 V Ranges)

745A VOLTAGE RANGE	MAXIMUM DISTORTION (at 100% of VOLTAGE RANGE)
100 mV	0.060%
1 V	0.051%
10 V	0.050%
100 V	0.050%

5-16. 1 mV and 10 mV Range Distortion Check.

5-17. The purpose of this check is to measure the harmonic distortion on the 745A 1 mV and 10 mV ranges. This check is performed using a wave analyzer to measure the individual harmonic components that are present on the 745A output signal. The curve shown in Figure 5-1 can be used to calculate the logarithmic sum of the various harmonics to obtain the total harmonic distortion figure.

SPECIFICATION:

± (0.05% of setting + 10 μV over 100 kHz bandwidth)

REQUIRED TEST EQUIPMENT:

Wave Analyzer (-hp- Model 3590A)

Load Resistor:
3.01 kilohm ± 1% 1/8 W (-hp- 0757-0273)

NOTE

Due to the exceptionally low output distortion of the Model 745A, it is difficult to detect the harmonic components by manually tuning the wave analyzer to the harmonic frequencies. For this reason, it is further recommended that an X-Y record(-hp- Model 7005B) be connected to the X (lin) and Y (log) outputs of the wave analyzer to provide a swept display of the frequency spectrum.

a. Connect the OUTPUT of the 745A to the input of the wave analyzer. Connect a 3 kilohm load resistor across the 745A OUTPUT terminals.

b. Set the 745A controls as follows:

VOLTAGE RANGE ..... 1 mV
Voltage Setting .....1.000000 mV
FREQUENCY .....1 kHz
ERROR RANGE 0

c. Set the wave analyzer controls as follows:

(-hp- Model 3590A control settings)
MAX. IN. VOLTAGE..0.01 (1 mV, 10 mV range), 0.1 (100 mV range)
ABSOLUTE/RELATIVE ..... RELATIVE
REF ADJ ..... MAX CW
METER .....LIN/dB
MODE .....RESTORED
RANGE (dB) ..... AUTO
BANDWIDTH (Hz) 100
RESPONSE TIME .....MED.
FREQUENCY .....1 kHz

d. If an X-Y recorder is not used, perform the wave analyzer frequency calibration (zero set) procedure as outlined in the wave analyzer operating and service manual.

e. If an X-Y recorder is used, perform the X (lin) and Y (log) calibration procedures as outlined in the wave analyzer operating and service manual.

f. Set the wave analyzer controls as follows:

SWEEP RATE ..... 100 Hz/sec.
SWEEP STARTING FREQ .....0 Hz (or to desired starting freq.)

g. Set the wave analyzer SWEEP control to START or manually tune the wave analyzer to each harmonic frequency to be measured (2nd through 4th) and record the readings in dB.

NOTE

The harmonic levels indicated on the meter of the wave analyzer (LIN/dB scale) are relative to a 0 dB input refer-

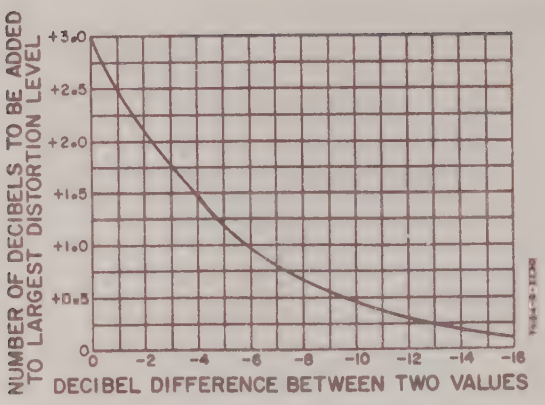


Figure 5-1. Logarithmic Addition of Harmonic Components

ence level. With an input of 1 mV rms, the input reference level is -20 dB (-hp- Model 3590A). For measurements with an input of 1 mV, it is then necessary to subtract (algebraically) the -20 dB reference level from the wave analyzer meter reading.

h. Calculate the total harmonic distortion (in dB)* using the logarithmic curve shown in Figure 5-1.

EXAMPLE:

If the 2nd harmonic is -63 dB and the third harminic is -60 dB, the largest distortion level is the third harmonic (-60 dB). The decibel difference between the second and third harmonics is -3 dB. Using the logarithmic curve shown in Figure 5-1, the number of dB to be added to the

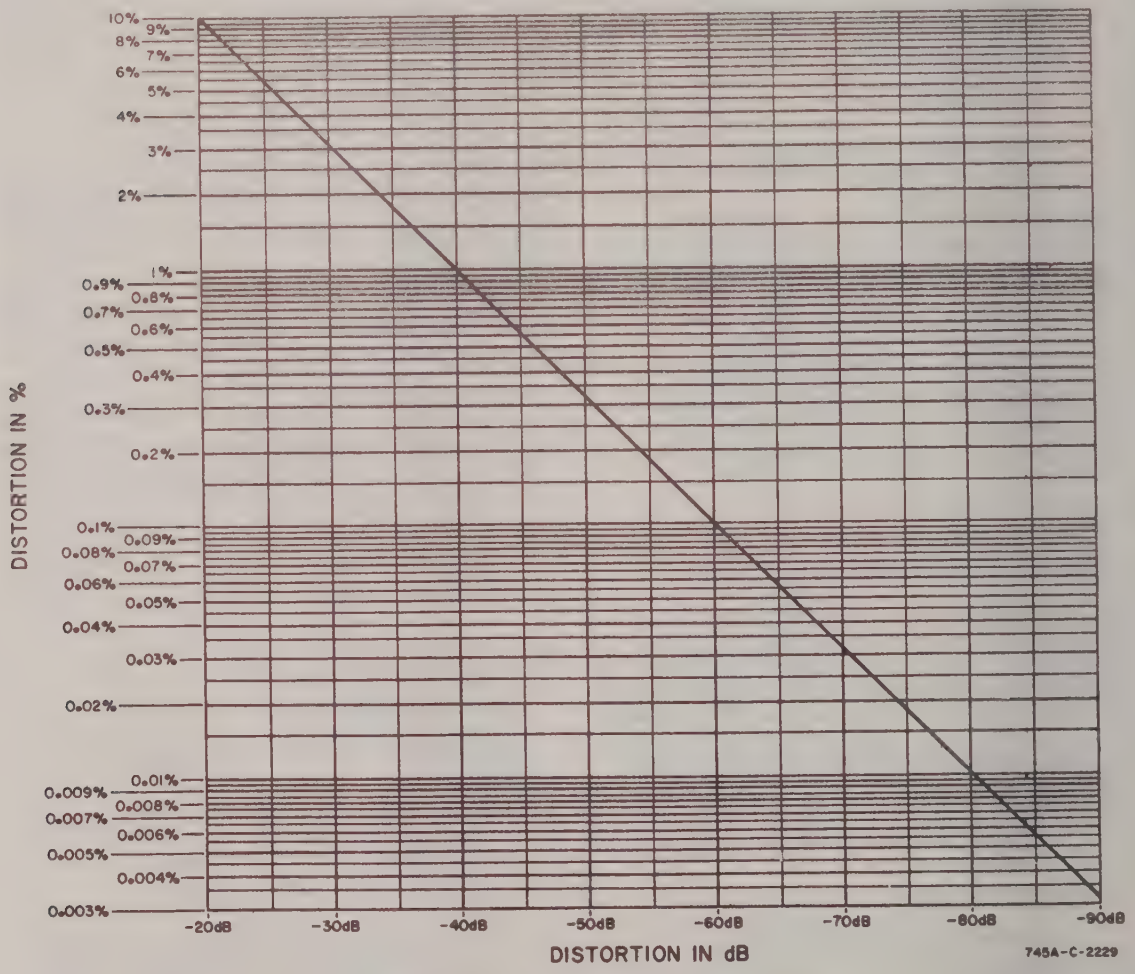


Figure 5-2. Conversion of dB to Percent

largest distortion level (-60 dB) is +1.75 dB. The total distortion introduced by the second and third harmonics is, therefore, -58.25 dB. The fourth harmonic, etc., can be added to this total in the same manner.

* The graph shown in Figure 5-2 can be used to convert the total harmonic distortion (THD) in dB to %THD.

i. The total harmonic distortion should be within the tolerances listed in Table 5-4.

j. Use the above procedure to measure the 745A output distortion on the 1 mV and 10 mV ranges for any fundamental frequencies within the range of 100 Hz to 110 kHz. Use the appropriate wave analyzer sweep rate and bandwidth for the frequency spectrum being measured.

k. If the 745A fails to meet any of the distortion specifications, refer to Paragraph 5-64.

5-18. ERROR MEASUREMENT ACCURACY CHECK.

5-19. The purpose of this check is to verify the accuracy of the % ERROR scale on the X1 and X.1 ERROR RANGE. Once the accuracy has been verified, the error measurement function can be used in the voltage accuracy checks to indicate the 745A output error in percent of setting.

SPECIFICATION:

± (0.51% of full scale)

Table 5-4. Distortion Check (1 mV and 10 mV Ranges)

745A VOLTAGE RANGE	MAXIMUM DISTORTION (at 100% of VOLTAGE RANGE)
1 mV	1.05% (-40 dB)
10 mV	0.15% (-56 dB)

REQUIRED TEST EQUIPMENT:

AC Differential Voltmeter (Fluke Model 883AB);

AC Divider Transformer (E.S.I. Model DT72A Dekatran)

a. Connect the 745A OUTPUT and SENSE to the input (1.0) of the ac divider transformer (Figure 5-3). Connect the output of the ac divider transformer to the input of the ac differential voltmeter.

b. Set the ac differential voltmeter to measure 1 volt. (0.99999 V, 1 V range). Set the ac divider controls to 1.0000000 (1:1 ratio).

c. Set the 745A controls as follows:

VOLTAGE RANGE ..... 1 V
Voltage Setting ..... 1.000000 V
FREQUENCY Scale 1.0
FREQUENCY RANGE ..... X1K (1 kHz)
ERROR RANGE 0
SENSE ..... REMOTE

d. Record the ac differential voltmeter reading: _____V.

e. Select the X1 ERROR RANGE. Set the ERROR MEASUREMENT control for an indication of 0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step d ± 0.00015 V.

f. Set the ac divider controls to 0.9708740. Set the ERROR MEASUREMENT control for an indication of -3.0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step d ± 0.00015 V.

g. Set the ac divider controls to 0.9803920. Set the ERROR MEASUREMENT control for an indication of -2.0 on the % ERROR scale. The ac

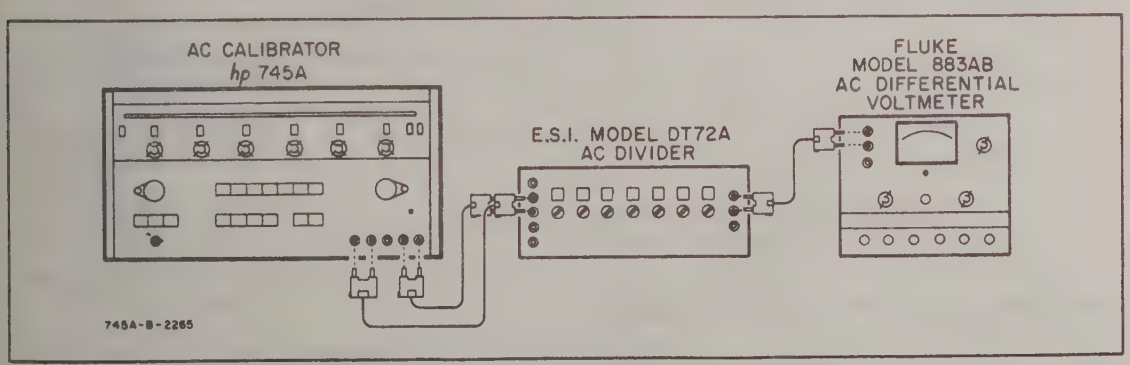


Figure 5-3. Error Measurement Accuracy Check

differential voltmeter should indicate the value recorded in Step d ± 0.00015 V.

h. Set the ac divider controls to 0.9900990. Set the ERROR MEASUREMENT control for an indication of −1.0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step d ± 0.00015 V.

i. Select the 745A 0 ERROR RANGE. Set the ac divider controls to 1.0000000. Record the ac differential voltmeter reading: _____V.

j. Set the ac divider controls to 1.0309290. Select the 745A X1 ERROR RANGE and set the ERROR MEASUREMENT control for an indication of +3.0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step i ± 0.00015 V.

k. Set the ac divider controls to 1.0204080. Set the ERROR MEASUREMENT control for an indication of +2.0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step i ± 0.00015 V.

l. Set the ac divider controls to 1.0101010. Set the ERROR MEASUREMENT control for an indication of +1.0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step i ± 0.00015 V.

m. Select the 745A 0 ERROR RANGE. Set the ac divider controls to 1.0000000. Record the ac differential voltmeter reading: _____V.

n. Select the X.1 ERROR RANGE. Set the ERROR MEASUREMENT control for an indication of 0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step m ± 0.000015 V.

o. Set the ac divider controls to 0.9970090. Set the ERROR MEASUREMENT control for an indication of −3.0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step m ± 0.000015 V.

p. Set the ac divider controls to 1.0030090. Set the ERROR MEASUREMENT control for an indication of +3.0 on the % ERROR scale. The ac differential voltmeter should indicate the value recorded in Step m ± 0.000015 V.

q. If the 745A fails to meet any of the error measurement accuracy specifications, refer to Paragraph 5-86.

5-20. VOLTAGE ACCURACY AND LOAD REGULATION CHECKS.

5-21. The purpose of the voltage accuracy and load regulation checks is to compare the 745A output voltage accuracy and load regulation to the combined voltage accuracy and load regulation specifications listed in Table 1-1. Each check should first be performed at 100% of voltage range to determine the overall accuracy of the instrument and to permit any necessary corrective adjustments (corrective adjustments are listed in Table 5-5). The following procedures can then be used to further verify the 745A output voltage accuracy at any voltage settings within the range of the measuring equipment. Note that the 745A combined voltage accuracy and load regulation is specified as a percentage of voltage setting and voltage range. The percentage of error tolerances listed in the procedures apply only to accuracy and load regulation checks at 100% of voltage range. If checks are to be performed at voltage settings other than 100% of voltage range, the percentage of error tolerances must be calculated from the voltage accuracy and load regulation specifications.

5-22. 1 V, 10 V and 100 V Accuracy and Load Regulation Checks.

NOTE

A thermal transfer voltmeter is recommended for the following 1 V, 10 V and 100 V Accuracy and Load Regulation Checks. If a thermal transfer voltmeter is not available, refer to Paragraph 5-24 for the alternate procedure requiring 1 V, 10 V and 100 V thermal converters. The thermal transfer voltmeter or thermal converters used for these checks should be calibrated by (or traceable to) the National Bureau of Standards.

5-23. The purpose of the following checks is to verify the 745A output voltage accuracy, load regulation and line regulation on the 1 V, 10 V and 100 V ranges. In the following procedure, the recommended load resistors and the 100 V, 100 kHz load capacitor will each provide a load current of 45 mA. When combined with the 5 mA load introduced by the thermal transfer voltmeter, the total load current will equal 50 mA.

SPECIFICATION:

FREQUENCY RANGE	COMBINED ACCURACY AND LOAD REGULATION
50 Hz to 20 kHz	± (0.032% of setting + 0.002% of range + 10 microvolts)
20 Hz to 50 Hz and 20 kHz to 110 kHz	± (0.062% of setting + 0.005% of range + 50 microvolts)
10 Hz to 20 Hz	± (0.212% of setting + 0.005% of range + 50 microvolts)

Load Regulation: Included in accuracy specifications.

Line Regulation: ± 0.001% of setting change in output voltage for a ± 10% change in line voltage. (Included in accuracy specifications.)

REQUIRED TEST EQUIPMENT:

Thermal Transfer Voltmeter (Holt Model 6* or Model 6A)

DC Standard (-hp- Model 740B)

Variable Line Transformer
(Superior Type UC1MB-115 V operation)
(Superior Type UC2MB-230 V operation)

* Holt Model 6 requires an external dc null voltmeter (-hp- Model 419A).

Load Resistors:
1 V Range: 22.1 ohm ± 1% 1/4 W (-hp- 0757-0497)
10 V Range: 221 ohm ± 1% 1/2 W (-hp- 0757-0805)
100 V Range:
series combination
2 kilohm ± 5% 5 W (-hp- 0812-0100)
221 ohm ± 1% 1/2 W (-hp- 0757-0805)

Load Capacitors:
100 V, 100 kHz:
parallel combination
240 pF ± 5% 300 V (-hp- 0140-0199)
470 pF ± 5% 300 V (-hp- 0140-0149)

a. Set the thermal transfer voltmeter controls as follows:

FUNCTION ..... STDBY
VOLTAGE RANGE ..... 1 V
SENSITIVITY ..... SEARCH COARSE

b. Connect test equipment as shown in Figure 5-4.

c. Set the dc standard for an output of 1 volt (0.999999 V, 1 V range).

d. Set the 745A controls as follows:

VOLTAGE RANGE ..... 1 V
VOLTAGE Setting ..... 1.000000 V
FREQUENCY RANGE X100
FREQUENCY Scale ..... 1.0 (100 Hz)
ERROR RANGE 0
SENSE ..... REMOTE

e. Set the thermal transfer voltmeter FUNCTION to DC.

f. Adjust the thermal transfer voltmeter SEARCH and COARSE controls for a zero reading on the null meter.

g. Allow an initial warmup period of at least thirty minutes before proceeding with the accuracy checks.

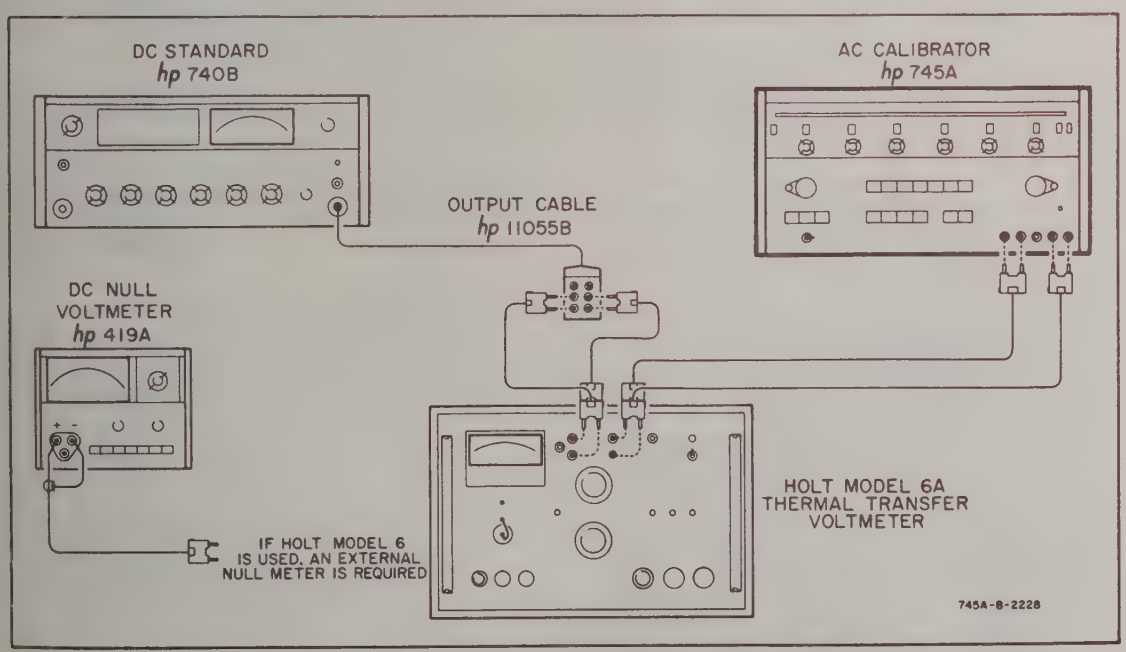


Figure 5-4. 1 V, 10 V and 100 V Accuracy Checks

h. Increase the thermal transfer voltmeter SENSITIVITY and adjust the MEDIUM and FINE BALANCE controls for a zero indication on the null meter.

NOTE

If an external dc null voltmeter is used, the fine dc balance adjustments and ac measurement should be performed with the dc null voltmeter set to the voltage range that will provide optimum resolution (10 μV range).

i. Set the thermal transfer voltmeter FUNCTION to AC.

j. Select the 745A X.1 ERROR RANGE and adjust the ERROR MEASRUEMENT control for a zero indication on the null meter.

k. Record the 745A output error as indicated on the % ERROR scale. Percentage of error tolerances and corrective adjustments (if any) are listed in Table 5-5. Retain 1 volt, 100 Hz error information for use in the Millivolt Range Accuracy Checks.

EXAMPLE:

If the indication on the 745A % ERROR scale is +0.2 and the selected ERROR RANGE is X.1, the 745A output error is: +0.2 X 0.1 = +0.02%. This indicates that the 745A output voltage is 0.02% high.

l. Set the thermal transfer voltmeter FUNCTION to DC and (if necessary) readjust the FINE BALANCE control for a zero indication on the null meter.

NOTE

Each transfer measurement (Steps i through l) should be performed at least twice to avoid errors due to drift or technique.

m. Connect the appropriate 1 V, 10 V or 100 V load resistor across the 745A OUTPUT terminals at the 745A front panel (correct load resistors are listed at the beginning of this procedure).

n. Set the thermal transfer voltmeter FUNCTION to AC and adjust the 745A ERROR MEASUREMENT control for a zero indication on the null meter.

o. The 745A output error (indicated on the % ERROR scale) should remain within the tolerances listed in Table 5-5, verifying the 745A output voltage accuracy with a 50 mA load.

p. Set the thermal transfer voltmeter FUNCTION to DC and remove the load resistor from the 745A OUTPUT terminals. If necessary, readjust the FINE BALANCE control for a zero indication on the null meter.

q. Set the thermal transfer voltmeter FUNCTION to AC and adjust the 745A ERROR MEASUREMENT control for a zero indication on the null meter.

NOTE

In the following step the 745A voltage setting can be increased by 0.001% (1000010) to determine the thermal transfer voltmeter's response to 0.001% variation. In most cases, a ± 10% line voltage variation will have a negligible effect on the 745A output voltage.

r. While observing the null meter, vary the 745A line voltage from 103.5 V to 126.5 V (115 V ± 10%) or from 207 V to 253 V (230 V ± 10%). The null meter should indicate a 745A output voltage variation of less than 0.001%. (Reset line voltage to 115 V or 230 V when check is completed.)

s. Set the thermal transfer voltmeter FUNCTION to DC and (if necessary) readjust the FINE BALANCE control for a zero indication on the null meter.

t. Repeat Steps i through l with the 745A set to each frequency listed in Table 5-5. At each frequency setting, the 745A output error should be within the tolerances listed in the table.

u. Set the 745A and test equipment controls as follows:

Thermal Transfer Voltmeter:
FUNCTION ..... STDBY
VOLTAGE RANGE ..... 10 V
SENSITIVITY ..... SEARCH COARSE

DC Standard:
10 volts (9.99999 V, 10 V range)

745A:
VOLTAGE RANGE ..... 10 V
Voltage Setting ..... 10.00000 V
Frequency ..... 100 Hz
ERROR RANGE 0
SENSE ..... REMOTE

v. Perform Steps e through t to verify the 745A output voltage accuracy and load regulation at 10.00000 V. Percentage of error tolerances and corrective adjustments (if any) are listed in Table 5-5.

w. Set the 745A and test equipment controls as follows:

Thermal Transfer Voltmeter
FUNCTION ..... STDBY
VOLTAGE RANGE ..... 100 V
SENSITIVITY ..... SEARCH COARSE

DC Standard:
100 volts (99.9999 V, 100 V range)

745A:
VOLTAGE RANGE ..... 100 V
Voltage Setting ..... 100.0000 V
Frequency ..... 100 Hz
ERROR RANGE 0
SENSE ..... REMOTE

x. Perform Steps e through t to verify the 745A output voltage accuracy and load regulation at 100.0000 V. Percentage of error tolerances and corrective adjustments (if any) are listed in Table 5-5.

y. Repeat Steps l through o with the 745A set to 100 V, 100 kHz. Use a 710 pF (240 pF + 470 pF) capacitive load in place of the load resistor (Step m).

z. *If the 745A fails to meet any of the required specifications, perform the corrective adjustments (if applicable) or refer to Paragraph 5-116.*

5-24. 1 V, 10 V and 100 V Accuracy and Load Regulation Checks (Alternate Procedure).

5-25. The purpose of the following checks is to verify the 745A output voltage accuracy, load regulation and line regulation on the 1 V, 10 V and 100 V ranges. In the following procedure, the recommended load resistors and the 100 V, 100 kHz load capacitor will each provide a load current of 45 mA. When combined with the 5 mA load introduced by the thermal converter, the total load current will equal 50 mA.

SPECIFICATION:

FREQUENCY RANGE	COMBINED ACCURACY AND LOAD REGULATION
50 Hz to 20 kHz	± (0.032% of setting + 0.002% of range + 10 microvolts)
20 Hz to 50 Hz and 20 kHz to 110 kHz	± (0.062% of setting + 0.005% of range + 50 microvolts)
10 Hz to 20 Hz	± (0.212% of setting ± 0.005% of range + 50 microvolts)

Load Regulation: Included in accuracy specifications.

Line Regulation: ± 0.001% of setting change in output voltage for a ± 10% change in line voltage. (Included in accuracy specifications.)

REQUIRED TEST EQUIPMENT:

1 V, 10 V, and 100 V Thermal Converters (Englehard 36850)

DC Standard (-hp- Model 740B)

DC Differential Voltmeter (-hp- Model 3420A/B)

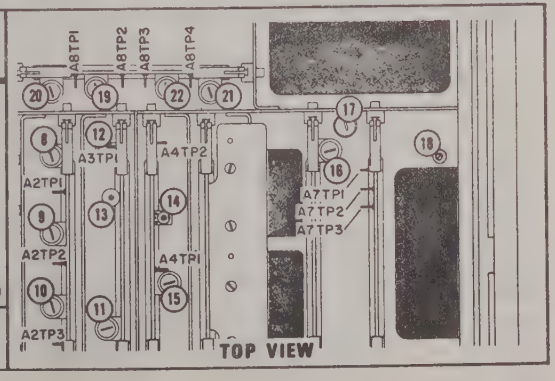
Variable Line Transformer
(Superior Type UC1MB-115 V operation)
(Superior Type UC2MB-230 V operation)

Load Resistors
1 V RANGE:
22.1 ohm ± 1% 1/4 W (-hp- 0757-0497)
10 V RANGE:
221 ohm ± 1% 1/2 W (-hp- 0757-0805)
100 V RANGE:
series combination
2 kilohm ± 5% 5 W (-hp- 0812-0100)
221 ohm ± 1% 1/2 W (-hp- 0757-0805)

Table 5-5. 1 V, 10 V and 100 V Accuracy Checks

745A FREQUENCY SETTING	% ERROR TOLERANCES (1 V RANGE)	% ERROR TOLERANCES (10 V RANGE)	% ERROR TOLERANCES (100 V RANGE)
100 Hz	± 0.035%	± 0.034%	± 0.034%
10 Hz	± 0.22%	± 0.22%	± 0.22%
20 Hz	± 0.072%	± 0.068%	± 0.067%
50 Hz	± 0.035%	± 0.034%	± 0.034%
1 kHz	± 0.035%	± 0.034%	± 0.034% (17)
10 kHz	± 0.035%	± 0.034%	± 0.034%
20 kHz	± 0.035%	± 0.034%	± 0.034%
50 kHz	± 0.072%	± 0.068%	± 0.067%
100 kHz	± 0.072% (13)	± 0.068% (16)	± 0.067% (18)

◯ Indicates corrective adjustment for corresponding VOLTAGE RANGE and frequency.



Load Capacitors:
100 V, 100 kHz:
parallel combination
240 pF ± 5% 300 V (-hp- 0140-0199)
470 pF ± 5% 300 V (-hp- 0140-0149)

a. Connect test equipment as shown in Figure 5-5. Connect the 745A power cord to a variable line transformer supplying 115 V or 230 Vac.

b. Set the dc standard for an output of 1 volt (0.999999 V, 1 V range).

c. Allow a stabilization period of 30 minutes before proceeding.

d. Measure the thermal converter output voltage using the dc differential voltmeter. Record the dc differential voltmeter reading.

e. Reverse the polarity of the connections to the thermal converter from the dc standard. Do not disturb the dc standard or dc differential voltmeter control settings.

f. Record the dc differential voltmeter reading.

NOTE

The accuracy of the test readings (Steps d and f) depends on the repeatability of the dc differential voltmeter. If possible, do not change the decade switch settings between the measurements in Steps c and e. Generally the two readings will vary less than 20 μV and can be noted by observing the change in the front panel meter deflection on the dc differential voltmeter.

g. Calculate and record the average value of the readings recorded in Steps d and f. This value represents the thermal converter's response to the dc input voltage and compensates for any inherent dc reversal error. If the reversal error (difference in readings Steps d and f) is greater than 20 μV, a thermal converter with less reversal error must be used.

h. Without disturbing the dc standard voltage setting, disconnect the dc standard from the thermal converter. Connect the 745A OUTPUT and SENSE leads to the input of the thermal converter.

CAUTION

DO NOT EXCEED THE RATED INPUT VOLTAGE TO THE THERMAL CONVERTER.

i. Set the 745A controls as follows:

VOLTAGE RANGE .....1 V (or to VOLTAGE RANGE to be checked)
Voltage Setting .....1.000000 (100% of VOLTAGE RANGE)
FREQUENCY RANGE X100
FREQUENCY Scale ..... 1.0 (100 Hz)
ERROR RANGE X.1
SENSE .....REMOTE

j. Vary the 745A ERROR MEASUREMENT control until the dc differential voltmeter indicates the exact value recorded in Step g.

k. Record the 745A output error as indicated on the % ERROR scale. Percentage of error tolerances

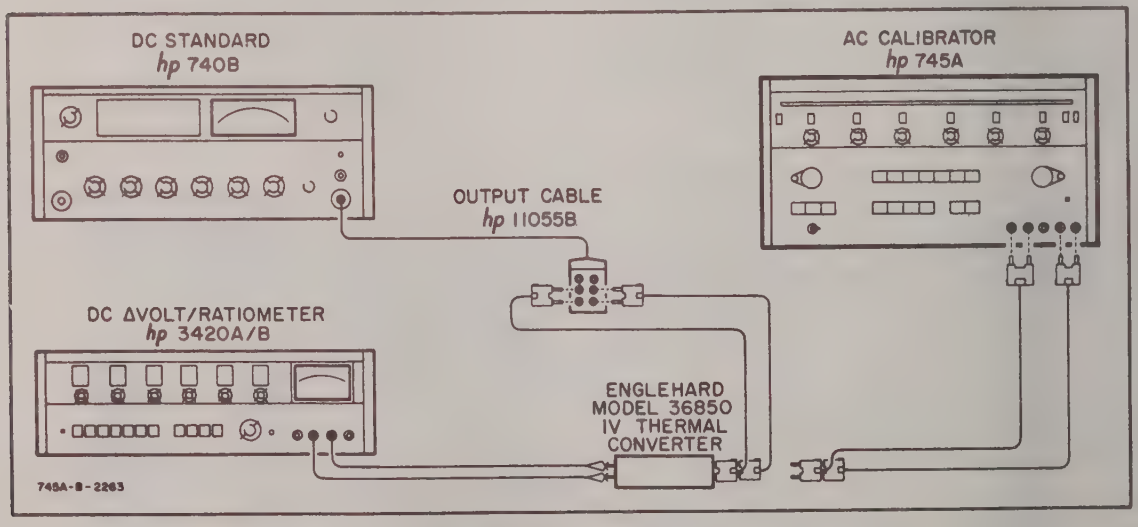


Figure 5-5. 1 V, 10 V and 100 V Accuracy Checks (Alternate Procedure)

and corrective adjustments (if any) are listed in Table 5-5. Retain 1 volt, 100 Hz error information for use in the Millivolt Range Accuracy Checks.

l. Disconnect the 745A and reconnect the dc standard to the input of the thermal converter. Repeat Steps d through k. (Steps d through k are repeated to minimize errors due to drift or technique.)

m. Connect the appropriate 1 V, 10 V or 100 V load resistor across the 745A OUTPUT terminals at the 745A front panel (correct load resistors are listed at the beginning of this procedure).

n. Vary the 745A ERROR MEASUREMENT control until the dc differential voltmeter indicates the exact value recorded in Step g. The 745A output error (indicated on the % ERROR scale) should be within the tolerances listed in Table 5-5, verifying the 745A output voltage accuracy with a 50 mA load.

CAUTION

TO PREVENT DAMAGE TO THE THERMAL CONVERTER, REDUCE THE 745A VOLTAGE RANGE TO 1 mV BEFORE REMOVING THE LOAD RESISTOR.

o. Select the 745A 1 mV range, remove the load resistor from the 745A OUTPUT terminals and reselect the 745A 1 V range and REMOTE SENSE.

NOTE

In the following step, the 745A voltage setting can be increased by 0.001% (1.000010 V) to determine the thermal converter's response to 0.001% variation. In most cases, a ± 10% line voltage variation will have a negligible effect on the 745A output voltage.

p. While observing the dc differential voltmeter reading, vary the 745A line voltage from 103.5 V to 126.5 V (115 V ± 10%) or from 207 V to 253 V (230 V ± 10%). The dc differential voltmeter should indicate a 745A output voltage variation of less than ± 0.001%, verifying the line regulation specification of ± 0.001%. (Reset the line voltage to 115 V or 230 V when check is completed.)

q. Disconnect the 745A and reconnect the dc standard to the input of the thermal converter. Repeat Steps d through l with the 745A set to each frequency listed in Table 5-5. At each frequency setting, the 745A 1 volt accuracy should be within the tolerances listed in Table 5-5 and on the Performance Check Test Card.

r. Connect test equipment as shown in Figure 5-5. Use a 10 V thermal converter.

s. Set the dc standard for an output of 10 volts (9.99999 V, 10 V range).

t. Repeat Steps c through n to verify the 745A output voltage accuracy and load regulation at 10.00000 V, 100 Hz.

u. Disconnect the 745A and reconnect the dc standard to the input of the thermal converter. Repeat Steps d through l with the 745A set to each frequency listed in Table 5-5. At each frequency setting, the 745A 10 volt accuracy should be within the tolerances listed in Table 5-5 and on the Performance Check Test Card.

v. Connect test equipment as shown in Figure 5-5. Use a 100 V thermal converter.

w. Set the dc standard for an output of 100 volts (99.9999 V, 100 V range).

x. Repeat Steps c through n to verify the 745A output voltage accuracy and load regulation at 100.0000 V, 100 Hz.

y. Disconnect the 745A and reconnect the dc standard to the input of the thermal converter. Repeat Steps d through l with the 745A set to each frequency listed in Table 5-5. At each frequency setting, the 745A 100 volt accuracy should be within the tolerances listed in Table 5-5 and on the Performance Check Test Card.

z. Connect the dc standard to the input of the thermal converter. Repeat Steps d through n with the 745A set to 100.0000, 100 kHz. Use a 710 pF (240 pF + 470 pF) capacitive load in place of the load resistor (Step m).

aa. If the 745A fails to meet any of the required specifications, perform the corrective adjustments (if applicable) or refer to Paragraph 5-116.

5-26. Millivolt Range Accuracy and Load Regulation Checks.

5-27. (Refer to Figure 5-6 for the following discussion.) The purpose of these checks is to verify the 745A output voltage accuracy and load regulation on the 1 mV, 10 mV and 100 mV ranges. In the following procedure, the 745A 1 volt, 100 Hz output is corrected by the amount of error recorded in the 1 volt accuracy checks. A precision ac divider transformer is used to divide the corrected 1 volt output to provide a 1 mV, 10 mV or 100 mV reference voltage. The reference voltage is amplified to a 1 volt level and is measured using an ac differential voltmeter. The 745A output is then connected directly to the input of the ac amplifier (divider transformer set to 1:1 ratio) and a

comparison is made between the reference voltage and the 745A 1 mV, 10 mV or 100 mV output voltage.

NOTE

In order to obtain accurate voltage measurements on the 1 mV, 10 mV and 100 mV ranges, the following steps should be taken to minimize undesirable ground currents.

a. Connect only the 745A OUTPUT to the input of the measuring equipment. Do not use remote SENSE connections.

b. Connect only one instrument in a test arrangement to power line ground. Connect all other instruments to the power source using 3-prong to 2-prong adapters (-hp- 1251-0048), leaving the ground leads disconnected.

SPECIFICATION:

FREQUENCY RANGE	COMBINED ACCURACY AND LOAD REGULATION
50 Hz to 20 kHz	± (0.04% of setting + 0.002% of Range + 10 microvolts)
20 Hz to 50 Hz and 20 kHz to 110 kHz	± (0.07% of setting + 0.005% of Range + 50 microvolts)
10 Hz to 20 Hz	± (0.22% of setting + 0.005% of Range + 50 microvolts)

REQUIRED TEST EQUIPMENT:

AC Divider Transformer
(E.S.I. Model DT72A Dekatran)

Precision AC Amplifier (-hp- Model 463A)

AC Differential Voltmeter (Fluke Model 883AB)

Load Resistor:
3.01 kilohm ¾ 1% 1/8 W (-hp- 0757-0273)

NOTE

Due to the accuracy and frequency response limitations of the ac divider transformer, the following accuracy checks are valid only within the frequency range of 100 Hz to 1 kHz. If further verification of the 745A mV range accuracy is required, refer to Paragraph 5-28 for the supplement procedure.

a. Connect test equipment as shown in Figure 5-6.

b. Set the 745A controls as follows:

VOLTAGE RANGE ..... 1 V
Voltage Setting ..... 1.000000 V
FREQUENCY RANGE X100
FREQUENCY Scale ..... 1.0 (100 Hz)
ERROR RANGE X.1
% ERROR Scale ..... Set to amount of error recorded in the 1 volt accuracy check for 1 V, 100 Hz.
SENSE ..... LOCAL

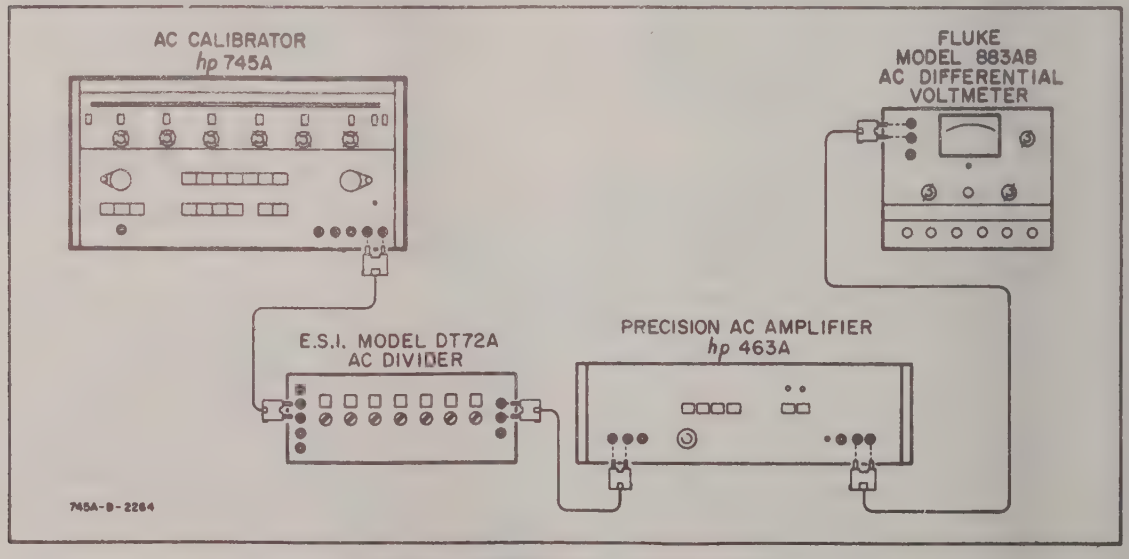


Figure 5-6. Millivolt Range Accuracy Checks

c. Set the ac divider controls to 0.001000 (1000:1 ratio). Set the ac amplifier gain to X1000.

NOTE

Retain the ac differential voltmeter readings (Steps d, j and p) for use in the supplement procedure.

d. Measure the amplifier output voltage with the ac differential voltmeter. Record the ac differential voltmeter reading: ____V.

e. Select the 745A 1 mV range. Set the ac divider controls to 1.000000 (1:1 ratio).

f. Select the 745A X1 ERROR RANGE and vary the ERROR MEASUREMENT control until the ac differential voltmeter indicates the exact value recorded in Step d.

g. Observe the 745A output error as indicated on the % ERROR scale. The output error should be less than ± 1.04%, verifying the 745A output voltage accuracy at 1 mV, 100 Hz.

h. Set the ac amplifier gain to X100. Set the ac divider controls to 0.010000 (100:1 ratio). Select the 745A 1 V range.

i. Select the 745A X.1 ERROR RANGE and set the ERROR MEASUREMENT control to the amount of error recorded in the 1 volt accuracy checks.

j. Measure the amplifier output voltage with the ac differential voltmeter. Record the ac differential voltmeter reading: ____V.

k. Select the 745A 10 mV range. Set the ac divider controls to 1.000000 (1:1 ratio).

l. Select the 745A X1 ERROR RANGE and vary the ERROR MEASUREMENT control until the ac differential voltmeter indicates the exact value recorded in Step j.

m. Observe the 745A output error as indicated on the % ERROR scale. The output error should be less than ± 0.142%, verifying the 745A output voltage accuracy at 10 mV, 100 Hz.

n. Set the ac amplifier gain to X10. Set the ac divider controls to 0.100000 (10:1 ratio). Select the 745A 1 V range.

o. Select the 745A X.1 ERROR RANGE and set the ERROR MEASUREMENT control to the amount of error recorded in the 1 volt accuracy checks.

p. Measure the amplifier output voltage with the ac differential voltmeter. Record the ac differential voltmeter reading: ____V.

q. Select the 745A 100 mV range. Set the ac divider controls to 1.000000 (1:1 ratio).

r. Select the 745A X.1 ERROR RANGE and vary the ERROR MEASUREMENT control until the ac differential voltmeter indicates the exact value recorded in Step p.

s. Observe the 745A output error as indicated on the % ERROR scale. The output error should be less than ± 0.052% verifying the 745A output voltage accuracy at 100 mV, 100 Hz.

t. Connect a 3 kilohm load resistor across the OUTPUT terminals at the 745A front panel.

u. Vary the 745A ERROR MEASUREMENT control until the ac differential voltmeter indicates the exact value recorded in Step p. The 745A output error (indicated on the % ERROR scale) should be less than ± 0.052%, verifying the 745A load regulation on the mV ranges.

v. The above procedure can be used to verify the 745A 1 mV, 10 mV and 100 mV accuracy for any frequency within the range of 100 Hz to 1 kHz. At each frequency setting to be checked, the ERROR MEASUREMENT control settings (Steps b, i and o) should correspond with the amount of error recorded in the 1 volt accuracy checks. If further verification of the 745A mV range accuracy is required, refer to Paragraph 5-28 for the supplement procedure.

w. *If the 745A fails to meet any of the mV range accuracy specifications, refer to Paragraph 5-116.*

5-28. Millivolt Range Accuracy Checks (supplement procedure).

5-29. Due to the accuracy and frequency response limitations of the ac divider transformer, the Millivolt Range Accuracy Checks (Paragraph 5-26) are valid only within the frequency range of 100 Hz to 1 kHz. The purpose of the following procedure is to supplement the Millivolt Range Accuracy Checks to permit verification of the 745A mV range accuracy for any frequency within the range of 20 Hz to 110 kHz. This procedure requires an N.B.S. calibrated (or N.B.S. traceable) micropotentiometer (Ballantine Model 440) that can be used as a 1 mV, 10 mV and 100 mV standard.

5-30. The following procedure is based on the 100 Hz reference readings that were previously recorded in the Millivolt Range Accuracy Checks. These readings represent the response of the measuring equipment (ac amplifier/ac differential voltmeter) to 1 mV, 10 mV, and 100 mV (100 Hz) reference voltages. The reference voltages are obtained by dividing the corrected 745A 1 volt output by 1000, 100, and 10 respectively.

5-31. In the following procedure, the test equipment is connected as shown in Figure 5-7 (the 745A serves only as a stable ac source). The gain of the amplifier is set to provide an output of 1 volt for the respective inputs of 1 mV, 10 mV or 100 mV from the micropotentiometer. The ac input to the micropotentiometer is varied in amplitude until the ac differential voltmeter reading is exactly equal to the 100 Hz reference reading recorded in the mV Range Accuracy Checks. The dc output of the micropotentiometer is measured using a high resolution dc differential voltmeter. This dc reading then becomes the reference for the various frequency settings. At each frequency setting for which an accuracy check is required, the ac input to the micropotentiometer is varied in amplitude until the dc output is exactly equal to the dc reference reading. Disregarding the minute frequency response variations of the micropotentiometer, the ac output amplitude will exactly equal the 100 Hz reference voltage. The ac output of the micropotentiometer is amplified to a 1 volt level and is measured using the ac differential voltmeter. These readings are recorded in Table 5-6 as the 1 mV, 10 mV and 100 mV reference readings. The output of the 745A is then connected directly to the input of the ac amplifier and a comparison is made between the reference readings and the 745A 1 mV, 10 mV or 100 mV output voltage.

5-32. The validity of these checks depends on the accuracy of the reference voltages obtained in the mV Range Accuracy Checks and on the stability and repeatability characteristics of the measuring equipment. Since these are comparison measurements, the ac differential voltmeter serves only as a high resolution indicating device. The test results are not affected by the frequency response of the ac amplifier or ac differential voltmeter.

SPECIFICATION:

FREQUENCY RANGE	COMBINED ACCURACY AND LOAD REGULATION
50 Hz to 20 kHz	± (0.04% of setting + 0.002% of Range + 10 microvolts)
20 Hz to 50 Hz and 20 kHz to 100 kHz	± (0.07% of setting + 0.005% of Range + 50 microvolts)
10 Hz to 20 Hz	± (0.22% of setting + 0.005% of Range + 50 microvolts)

REQUIRED TEST EQUIPMENT:

Micropotentiometer with a 5 mA thermocouple and the following radial resistors: (Ballantine Model 440 Micropotentiometer)

1 mV: 0.22 ohm
10 mV: 2.2 ohm
100 mV: 22 ohm

DC Differential Voltmeter (-hp- Model 3420A/B)

Precision AC Amplifier (-hp- Model 463A)

AC Differential Voltmeter (Fluke Model 883AB)

a. Perform the mV Range Accuracy Checks as outlined in Paragraph 5-26.

b. In the spaces below, rerecord the ac differential voltmeter readings that were previously recorded

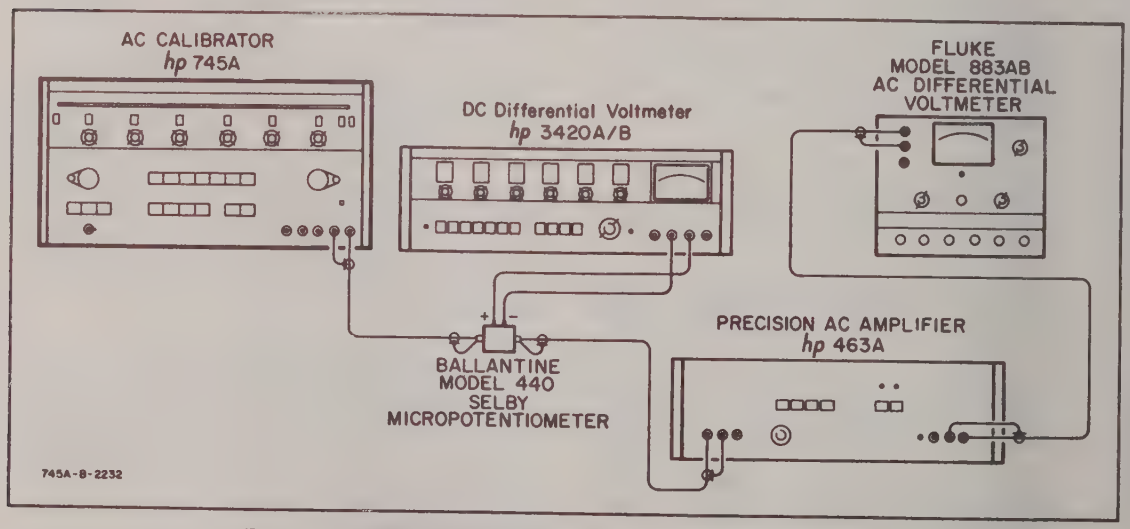


Figure 5-7. Millivolt Range Accuracy Checks (Supplement Procedure)

in Steps d, j and p of the mV Range Accuracy Checks (Paragraph 5-26).

1 mV (Step d):____V

10 mV (Step j):____V

100 mV (Step p):____V

c. Install a 0.22 ohm (1 mV output) radial resistor in the micropotentiometer.

d. Connect test equipment as shown in Figure 5-7.

CAUTION

CONNECT TEST EQUIPMENT WITH THE 745A SET TO THE 1 mV RANGE. DO NOT EXCEED THE RATED INPUT VOLTAGE TO THE MICROPOTENTIOMETER.

e. Set the ac differential voltmeter to measure 1 volt (0.9999 V, 1 V range).

f. Set the ac amplifier gain to X1000.

g. Set the 745A controls as follows:

Voltage Setting ..... 0.100000 V
VOLTAGE RANGE ..... 1 V
FREQUENCY RANGE X100
Frequency Scale ..... 1.0 (100 Hz)
ERROR RANGE 0
SENSE ..... LOCAL

NOTE

The following step will be performed once for each of the mV ranges. Use the ac differential voltmeter reference reading (Step b) that corresponds with the voltage being measured.

h. Increase the 745A voltage setting until the ac differential voltmeter indicates the exact value recorded in Step b. (745A voltage setting will be approximately 0.5 V.)

NOTE

For increased stability, allow a warmup period of at least 1/2 hour before proceeding. Repeat Steps h and i as necessary to minimize errors due to drift or technique.

i. Measure the micropotentiometer dc output voltage with the dc differential voltmeter. Record the dc differential voltmeter reading:

_____ V

_____ V

_____ V

j. Select the 745A X10 FREQUENCY RANGE and adjust the FREQUENCY control for an indication of 2.0 on the FREQUENCY scale (20 Hz).

k. Select the 745A X1 ERROR RANGE and vary the ERROR MEASUREMENT control until the dc differential voltmeter indicates the exact value recorded in Step i. Record the ac differential voltmeter reading in the appropriate space provided in Table 5-6.

l. Repeat Step k with the 745A set to each frequency listed in Table 5-6.

m. Install a 2.2 ohm (10 mV output) radial resistor in the micropotentiometer. Reconnect test equipment as shown in Figure 5-7.

n. Set the ac amplifier gain to X100.

o. Repeat Steps g through l.

p. Install a 22 ohm (100 mV output) radial resistor in the micropotentiometer. Reconnect test equipment as shown in Figure 5-7.

q. Set the ac amplifier gain to X10.

r. Repeat Steps g through l.

Table 5-6. Millivolt Range Accuracy Checks

745A FREQUENCY	1 mV Range		10 mV Range		100 mV Range	
	REF. READINGS	TOLERANCES	REF. READINGS	TOLERANCES	REF. READINGS	TOLERANCES
20 Hz	____V	±5.07%	____V	±0.575%	____V	±0.125%
50 Hz	____V	±1.04%	____V	±0.142%	____V	±0.052%
100 Hz	____V	±1.04%	____V	±0.142%	____V	±0.052%
1 kHz	____V	±1.04%	____V	±0.142%	____V	±0.052%
10 kHz	____V	±1.04%	____V	±0.142%	____V	±0.052%
100 kHz	____V	±5.07%	____V	±0.575%	____V	±0.125%

s. Disconnect the micropotentiometer and dc differential voltmeter. Connect the 745A OUTPUT directly to the INPUT of the ac amplifier.

t. Set the ac differential voltmeter to measure 1 volt (0.9999 V, 1 V range). Set the ac amplifier gain to X1000. Set the 745A controls as follows:

VOLTAGE RANGE ..... 1 mV
Voltage Setting .....1.000000 mV
FREQUENCY RANGE X10
FREQUENCY Scale .....2.0 (20 Hz)
ERROR RANGE X1
SENSE ..... LOCAL

u. Vary the 745A ERROR MEASUREMENT control until the ac differential voltmeter indicates the exact value recorded in Table 5-6 (value recorded in Table 5-6 that corresponds with 745A VOLTAGE RANGE and frequency setting).

v. Observe the 745A output error as indicated on the % ERROR scale. Percentage of error tolerances are listed in Table 5-6 and on the Performance Check Test Card.

NOTE

The millivolt range accuracy at 100 kHz can be adjusted by changing the values of A6C1* and A6C2* which are connected in parallel. Increasing the total capacitance by 30 pF will increase the output voltage by approximately 0.01% on the 100 mV range (100% of range), 0.1% on the 10 mV range and 1% on the 1 mV range.

w. Repeat Steps u and v with the 745A set to each frequency listed in Table 5-6.

x. Set the ac amplifier gain to X100. Select the 745A 10 mV VOLTAGE RANGE. Repeat Steps u and v with the 745A set to each frequency listed in Table 5-6.

y. Set the ac amplifier gain to X10. Select the 745A 100 mV VOLTAGE RANGE and X.1 ERROR RANGE. Repeat Steps u and v with the 745A set to each frequency listed in Table 5-6.

z. *If the 745A fails to meet any of the mV range accuracy specifications, refer to Paragraph 5-116.*

5-33. ADJUSTMENT PROCEDURES.

5-34. This portion of Section V contains complete adjustment procedures for the Model 745A AC Calibrator. Included are Power Supply and Bias Adjustments (Paragraph 5-44), Oscillator Adjustments (Paragraph 5-64), 100 kHz Response and 100 V Accuracy Adjustments (Paragraph 5-77), Frequency Scale Tracking Adjustments (Paragraph 5-80) and Error Scale Zero Adjustment (Paragraph 5-86).

5-35. TEST EQUIPMENT.

5-36. The test equipment required for the adjustments is listed in Table 5-1 and at the beginning of each adjustment procedure. If the recommended model is not available, any instrument that has specifications equal to or better than the required specifications can be used.

5-37. TEST POINT AND ADJUSTMENT LOCATION.

5-38. Test point and adjustment locations are shown in Figures 5-32 (top view) and 5-33 (bottom view). Figures 5-32 and 5-33 are located on a single fold-out at the end of Section V. The component designator for each adjustment is followed by a numerical call-out (Example: A2R9 (8)). The numerical call-outs correspond with the call-outs in the locator drawings and schematic diagrams. Table 5-7 lists the numerical call-out, component designator, function and schematic number of each adjustment.

5-39. Test points and adjustments that are not located at the top of a circuit board can be reached by placing the board on a printed-circuit board extender. A 15-pin extender (-hp- Part No. 5060-0049) and a 22-pin extender (-hp- Part No. 5060-0630) are supplied with the instrument.

CAUTION

TURN OFF THE 745A BEFORE INSTALLING OR REMOVING A PRINTED-CIRCUIT BOARD. IF A PRINTED-CIRCUIT BOARD EXTENDER IS USED, BE CAREFUL TO ORIENT THE BOARD PROPERLY IN THE EXTENDER.

5-40. PRINTED-CIRCUIT BOARD REMOVAL.

5-41. Circuit boards that plug into the main frame or into the Reference Square Wave Assembly (A1) can be removed by lifting the extractors at each end of the board. The extractors are color coded to match the corresponding guides on the main frame and A1 sheet metal. Circuit boards in the Oscillator Assembly (A12) can be removed by inserting a hook or other tool in the hole at the top of the

Table 5-7. Adjustments

CALL OUT	DESIGNATOR	FUNCTION	SCHEMATIC
(1)	A1A3R9	Positive AC Feedback (inside loop)	3
(2)	A1A3R26	Negative AC Feedback (inside loop)	3
(3)	A1A3R16	+ 9.9 V Fine Adjust	3
(4)	A1A3R14	+ 9.9 V Coarse Adjust	3
(5)	A1A3R32	−9.9 V Coarse Adjust	3
(6)	A1A3R34	− 9.9 V Fine Adjust	3
(7)	A1A4R5	Ref. Square Wave Frequency	4
(8)	A2R9	Thermocouple Driver Balance	5
(9)	A2R34	Error Amplifier Balance	5
(10)	A2R67	Integrator Ampl. Balance	5
(11)	A3R10	Sample Gate Frequency	6
(12)	A3R34	Sampling Ampl. Balance	6
(13)	A3C12	100 kHz Response	6
(14)	A4R8	Preamplifier Balance	7
(15)	A4R39	Low Frequency Balance	7
(16)	A6R16	10 V, 100 kHz Adjust	9
(17)	A14R7	100 V, 1 kHz Adjust	10
(18)	C9	100 V, 100 kHz Adjust	10
(19)	A8R6	+ 5.2 V Adjust	11
(20)	A8R29	− 25 V Adjust	11
(21)	A8R34	+ 70 V Adjust	11
(22)	A8R30	−70 V Adjust	11
(23)	A12L1	Oscillator Frequency	14
(24)	A12C2	Oscillator Freqeuncy	14
(25)	A12A2T1	Amplitude Adjust	15
(26)	A12A3T1	Amplitude Adjust	15
(27)	A12A4T1	Amplitude Adjust	15
(28)	A12A2C11	Bandpass	15
(29)	A12A3C11	Bandpass	15
(30)	A12A4C11	Bandpass	15
(31)	A12A2C14	Bandpass	15
(32)	A12A3C14	Bandpass	15
(33)	A12A4C14	Bandpass	15
(34)	A12A2C18	Bandpass	15
(35)	A12A3C18	Bandpass	15
(36)	A12A4C18	Bandpass	15
(37)	A12A5T1	5 MHz Amplitude	16
(38)	A12A5L2	555 kHz Sync.	16
(39)	A12A5T2	555 kHz Amplitude	16
(40)	A12A6T1	AC Level	17
(41)	A12A6L2	RF Ampl. Bias	17
(42)	A12A6R4	AGC Level	17
(43)	A12A7C14	Modulator Bal.	18
(44)	A12A7R26	Modulator Bal.	18
(45)	A12A7R29	Modulator Bal.	18
(46)	A12A8R15	Output Ampl. Bias	19
(47)	A12A8R32	Output Ampl. Gain	19

board. Lift or pry upward until the board is unplugged; be careful not to exert lateral pressure on the board. Refer to Paragraph 5-97 for further information concerning the removal and replacement of assemblies and components.

CAUTION

DO NOT ATTEMPT TO REMOVE OR REPLACE THE OVEN CONTROL AND SWITCH DRIVE GENERATOR (A1A4) WITHOUT FIRST REMOVING THE 19.8 V SQUARE WAVE GENERATOR (A1A3).

5-42. CONDENSED ADJUSTMENTS.

5-43. A Condensed Adjustment Procedure (Paragraph 5-92) is located at the end of the step-by-step adjustment procedures. The condensed procedure is provided for the convenience of those who regularly service the Model 745A and are basically familiar with the adjustment procedures.

5-44. POWER SUPPLY AND BIAS ADJUSTMENTS.

5-45. The following power supply and bias adjustments should be performed each 90 days as part of the routine maintenance for the Model 745A.

5-46. Regulated Power Supply Adjustments.

5-47. The following adjustments set the regulated power supply voltages to the proper value. Refer to Figure 5-32 for test point and adjustment locations.

REQUIRED TEST EQUIPMENT:

DC Voltmeter (-hp- Model 412A)

NOTE

In the following adjustment procedures, all voltages are measured with respect to circuit common (⏚). Circuit common is available at any point on the inner chassis.

a. Connect dc voltmeter to A8TP3.

b. Adjust A8R30 (22) for an indication of -70 V ± 0.5 Vdc.

c. Connect dc voltmeter to A8TP4.

d. Adjust A8R34 (21) for an indication of +70 V ± 0.5 Vdc.

e. Connect dc voltmeter to A8TP1.

f. Adjust A8R29 (20) for an indication of -25 V ± 0.2 Vdc.

g. Connect dc voltmeter to A8TP2.

h. Adjust A8R6 (19) for an indication of +5.2 V ± 0.1 Vdc.

5-48. Preamplifier Balance Adjustment.

5-49. This adjustment sets the operating level of the Preamplifier (A4) and the Power Amplifier (A5).

REQUIRED TEST EQUIPMENT:

DC Voltmeter (-hp- Model 412A)

a. Set 745A frequency to 1 kHz.

b. Connect dc voltmeter to A4TP1.

c. Adjust A4R8 (14) for an indication of 0 V ± 3 mVdc.

5-50. Sampling Amplifier Balance Adjustment.

5-51. This adjustment balances the differential section of the Sampling Amplifier (A3).

REQUIRED TEST EQUIPMENT:

DC Voltmeter (-hp- Model 412A)

a. Set 745A frequency to 50 kHz.

b. Turn off the reference square wave by setting A1A4S1 to the +9.9 V position.

c. Connect dc voltmeter to A3TP1.

d. Adjust A3R34 (12) for an indication of 0 V ± 1 mVdc.

e. Remove connection to A3TP1 and return A1A4S1 to the 19.8 V p-p (center) position.

5-52. Sample Rate Adjustment.

5-53. This adjustment sets the sample gate frequency to 2 Hz (X100 through X10K FREQUENCY RANGE).

REQUIRED TEST EQUIPMENT:

Electronic Counter (-hp- Model 5216A)

PC Board Extender (22-pin) (-hp- 5060-0630)

a. Turn the instrument off. Place the Error Amplifier

Assembly (A2) on a printed-circuit board extender. Turn the instrument on.

b. Set the electronic counter to measure period (0.1 mSec. time base) for an input amplitude of 30 V p-p.

c. Connect the electronic counter input to A2 pin 12.

d. Adjust A3R10 (11) for a sample period of 500 mSec. ± 50 mSec.

e. Leave the A2 Assembly on the extender for the following procedure.

5-54. Error Amplifier Bias Adjustments.

5-55. The following adjustments balance the differential amplifier sections in the Error Amplifier Assembly (A2).

REQUIRED TEST EQUIPMENT:
DC Voltmeter (-hp- Model 412A)

PC Board Extender (22-pin) (-hp- 5060-0630)

a. Turn the instrument off. Remove the Sampling Amplifier Assembly (A3). Place the Error Amplifier Assembly (A2) on a printed-circuit board extender. Turn the instrument on.

b. Connect dc voltmeter to A2TP1.

c. Adjust A2R9 (1) for an indication of 0 V ± 1 mVdc.

d. Turn the instrument off. Replace A3 and turn the instrument on.

e. Connect dc voltmeter to A2TP2.

f. Adjust A2R34 (1) for an indication of +0.6 V ± 0.05 Vdc.

g. Connect dc voltmeter to A2TP3.

h. Adjust A2R67 (18) for an indication of 0 V ± 0.1 mVdc.

i. This completes the Error Amplifier Bias Adjustments. Turn the instrument off, remove the PC board extender and replace A2.

5-56. AGC Level Adjustment.

5-57. This adjustment sets the nominal AGC voltage input to the RF Amplifier (A12A6).

REQUIRED TEST EQUIPMENT:
DC Voltmeter (-hp- Model 412A)

a. Set the 745A frequency to 1 kHz on the X1K FREQUENCY RANGE.

b. Connect dc voltmeter to A2TP4.

c. If the dc voltmeter indication is - 1 V ± 0.1 Vdc, the following adjustment is not required.

NOTE

In order to gain access to the AGC level adjustment (A12A6R4 (34)), the instrument must be placed on it's side and the bottom covers and the Oscillator Assembly (A12) cover removed.

d. With the dc voltmeter connected to A2TP4, adjust A12A6R4 (34) for an indication of - 1 V ± 0.1 Vdc.

5-58. Low Frequency Balance Adjustment.

5-59. This adjustment matches the low frequency and high frequency output network characteristics to provide optimum AGC sensitivity and response.

REQUIRED TEST EQUIPMENT:
DC Voltmeter (-hp- Model 412A)

a. Connect dc voltmeter to A2TP4.

b. Set the 745A frequency to 1 kHz on the X1K FREQUENCY RANGE.

c. Record the dc voltmeter reading: ____V (approximately -1 Vdc).

d. Set the 745A frequency to 1 kHz on the X100 FREQUENCY RANGE.

e. Adjust A4R39 (15) for the same dc voltmeter reading recorded in Step c.

5-60. Reference Square Wave Frequency Adjustment.

5-61. This adjustment sets the frequency of the reference square wave to 500 Hz.

REQUIRED TEST EQUIPMENT:

Electronic Counter (-hp- Model 5216A)

a. Connect electronic counter to A1A3TP5 (19.8 V p-p).

b. Adjust A1A4R5 (7) for an indication of 500 Hz ± 1 Hz on the electronic counter.

5-62. Reference Square Wave Voltage Adjustment.

5-63. This adjustment sets the amplitude of the reference square wave which establishes the accuracy of the 745A output voltage.

REQUIRED TEST EQUIPMENT:
DC Differential Voltmeter (-hp- Model 3420A/B)

NOTE

Allow a warmup period of at least one hour before performing these adjustments.

a. Set A1A4S1 to the -9.9 V position.

NOTE

The following test points and adjustments are accessable through slots in the cover of the A1 Assembly. In order to maintain the normal operating temperature, do not remove the A1 top cover. When connecting to the A1 test points, be careful not to short test points to the A1 top cover. Shorting the test points will not damage the instrument but will cause temporary instablility and possible errors in the voltage readings.

* See Note on page 5-46.

b. Set the differential voltmeter to measure -9.9 Vdc.

c. Connect the dc differential voltmeter to A1A3TP5.

d. Adjust A1A3R34 (8) (-9.9 V FINE ADJ.) for an indication of -9.9 V ± 10 μVdc on the dc differential voltmeter. If the correct setting is not within the range of the fine adjustment, carefully adjust A1A3R32 (9) (-9.9 V COARSE ADJ.) and then make the final adjustment with A1A3R34 (8)

e. Disconnect the dc differential voltmeter from A1A3TP5 and set the dc differential voltmeter to measure +9.9 Vdc.

f. Set A1A4S1 to the +9.9 V position.

g. Reconnect the dc differential voltmeter to A1A3TP5.

h. Select the 745A 0 ERROR RANGE and adjust the ERROR MEASUREMENT control for a zero indication on the % ERROR scale.

i. Adjust A1A3R16 (3) (+9.9 V FINE ADJ.) for an indication of +9.9 V ± 10 μVdc on the dc differential voltmeter. If the correct setting is not within the range of the fine adjustment, carefully adjust A1A3R14 (4) (+9.9 V COARSE ADJ.) and then make the final adjustment with A1A3R16 (3)

j. Without disturbing the 745A or test equipment connections or control settings, vary the 745A ERROR MEASUREMENT control over the entire range of the % ERROR scale. The dc differential voltmeter indication should not vary more than ± 20 μV.

k. If the dc differential voltmeter variation (Step J) is greater than ±20 μV, (0 ERROR RANGE) this indicates a malfunction in the error measurement network which is part of the A1A4 Assembly (Schematic No. 4). In most cases, this is caused by open or resistive contacts in A1A4K1 or A1A4K2.

l. This completes the Reference Square Wave Adjustment procedure. Disconnect the dc differential voltmeter and reset A1A4S1 to the 19.8 V p-p position.

NOTE

There are two remaining adjustments for the Reference Square Wave Assembly (A1). These adjustments, A1A3R9 (1) and A1A3R26 (2) are not required unless A1A3 has been repaired or replaced. Refer to Paragraph 5-154 for further information.

5-64. OSCILLATOR ADJUSTMENTS.

5-65. The purpose of the following adjustments is to set the various operating levels and tuned circuit characteristics in the 745A Oscillator Assembly (A12). The Modulator Balance Adjustments (Paragraph 5-71) and the Output Amplifier Adjustments (Paragraph 5-73) should be checked or performed each 90 days. The remaining oscillator adjustments are not normally required at 90-day intervals; however, periodic adjustment is recommended to ensure optimum performance of the instrument. These adjustments should *always* be performed if one of the following conditions exists:

a. If the 745A output distortion (Paragraph 5-11) is out of tolerance.

b. In the event of a malfunction such as no output, output error, oscillations, crossover distortion, etc. that is present on all VOLTAGE RANGES and one or some FREQUENCY RANGES or FREQUENCY settings.

c. If a repair has been made in any portion of the Oscillator Assembly.

5-66. The locations of test points and adjustments within the Oscillator Assembly are shown in Figure 5-33. In most cases, it is necessary to place the printed-circuit boards on a 15-pin extender (-hp- Part No. 5060-0049) to gain access to the test points and adjustments. Refer to Paragraph 5-37 before proceeding.

NOTE

In the following adjustment procedures, all ac and dc measurements are made with respect to circuit ground *unless otherwise specified*. Use a 10 Megohm, 10 pF 10:1 Divider Probe (-hp- 10004A) for oscilloscope measurements.

5-67. 5 MHz Oscillator and 9:1 Divider Adjustments.

5-68. The following adjustments set the 5 MHz and 555 kHz outputs of A12A5 to the correct amplitude and frequency.

REQUIRED TEST EQUIPMENT:

Oscilloscope (-hp- Model 180A W/10:1 Divider Probe)

a. Place A12A5 on a printed-circuit board extender.

b. Connect oscilloscope to A12A5TP1.

c. Adjust A12A5T1 (21) for maximum amplitude of the 5 MHz signal (0.75 V p-p nominal).

d. Connect oscilloscope to A12A5TP2.

e. Set the oscilloscope time base to 2 μSec/cm (calibrated).

f. Check for eleven complete cycles in 10 cm on the oscilloscope (Figure 5-8). If eleven cycles are not present, adjust A12A5L2 (20) until eleven cycles are obtained.

g. Adjust A12A5L2 (20) for maximum signal amplitude and then reduce amplitude until the waveform appears as shown in Figure 5-8.

h. Repeat Steps b through g until optimum adjustment is obtained.

i. Connect oscilloscope to A12A5 pin 1.

j. Adjust A12A5T2 (19) for maximum amplitude of the 555 kHz signal (0.4 V p-p nominal).

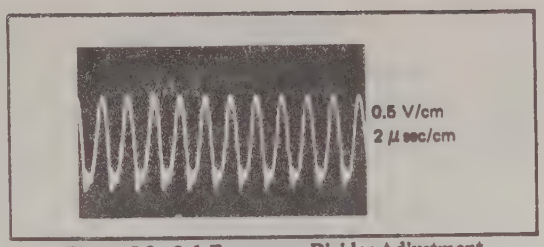


Figure 5-8. 9:1 Frequency Divider Adjustment

k. This completes the 5 MHz Oscillator and 9:1 Divider Adjustments. Remove the printed-circuit board extender and replace A12A5 in the A12 Assembly.

5-69. RF Amplifier Adjustments.

5-70. The following adjustments set the operating level and gain of the RF Amplifier to provide maximum AGC sensitivity.

REQUIRED TEST EQUIPMENT:

Oscilloscope (-hp- Model 180A W/10:1 Divider Probe)

DC Voltmeter (-hp- Model 412A)

CAUTION

IN THE FOLLOWING STEPS, THE DC VOLTMETER COMMON MUST BE ISOLATED FROM GROUND.

a. Place A12A6 on a printed-circuit board extender.

b. Connect the dc voltmeter probe to A12A6TP2; connect the common (low) dc voltmeter lead to A12A6TP1.

c. Connect oscilloscope to A12A6TP3 (referenced to circuit common).

d. Adjust A12A6L2 (18) for a minimum reading on the dc voltmeter (approximately + 3 Vdc).

e. While observing the oscilloscope waveform, adjust A12A6T1 (22) for minimum signal amplitude (approximately 3.5 V p-p).

f. Repeat Steps d and e until optimum adjustment is obtained.

g. This completes the RF Amplifier Adjustments. Remove the printed-circuit board extender and replace A12A6 in the A12 Assembly.

5-71. Modulator Balance Adjustments.

5-72. The following adjustments balance the ring modulator portion of the Modulator Assembly (A12A7). These adjustments reduce the harmonic distortion that is present at the output of the 745A.

REQUIRED TEST EQUIPMENT:

Oscilloscope (-hp- Model 180A W/10:1 Divider Probe)

DC Voltmeter (-hp- Model 412A)

a. Remove A12A5. Place the Modulator Assembly (A12A7) on a printed-circuit board extender.

b. Set the 745A frequency to 50 kHz.

c. Connect oscilloscope to A12A7TP2. Set time base to 0.5 μSec/cm.

d. Connect dc voltmeter to A12A8TP1.

e. Center potentiometers A12A7R26 (38) and A12A7R29 (37).

f. Adjust A12A7C14 (38) for minimum amplitude of the ac signal displayed on the oscilloscope.

g. Alternately adjust A12A7R26 (38) and A12A7R29 (37) for minimum amplitude of the ac signal.

h. Repeat Steps f and g until optimum adjustment (Figure 5-9) is obtained. The amplitude of the ac signal should be less than 0.05 V p-p.

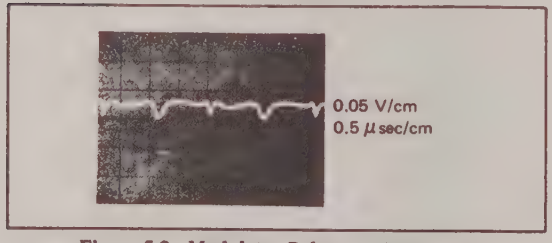


Figure 5-9. Modulator Balance Adjustment

NOTE

Spikes that appear on the waveform (Figure 5-10) causing the ac amplitude to exceed 0.05 V p-p are normally caused by a mismatch between diodes A12A7CR4 through A12A7CR7 (Schematic No. 18). Excessive spikes will cause an inherent unbalance in the modulator which can be noted by observing the dc offset (Step i). This condition can be corrected by replacing diodes A12A7CR4 through A12A7CR7 one at a time while attempting to adjust for the optimum waveform shown in Figure 5-9. It may be necessary to replace each diode several times before satisfactory results are obtained.

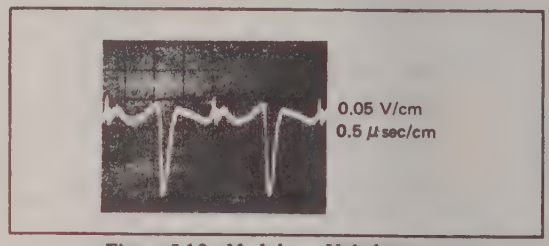


Figure 5-10. Modulator Unbalance

i. Observe the dc voltmeter reading. With the ac balance properly adjusted (Steps f and g) the dc voltmeter reading should be 0 V ± 10 mVdc (nominal).

j. Alternately adjust A12A7R26 (38) and A12A7R29 (37) (slightly) for an indication of 0 V ± 2 mVdc on the dc voltmeter.

k. Repeat Steps g through j as necessary to obtain optimum adjustment. The modulator is properly balanced when the amplitude of the ac component is less than 0.05 V p-p (Figure 5-9) and the dc voltage is 0 V ± 2 mVdc.

NOTE

A failure in the gain control circuitry (A12A7Q1, Q2) can cause the waveform at TP2 to appear as shown in Figure 5-9 but slightly lower in amplitude. If these adjustments are being performed due to output distortion, check the dc voltages in the gain control circuitry (Schematic No. 18) to verify correct operation.

l. This completes the Modulator Balance Adjustments. Replace A12A5 and A12A7 in the A12 Assembly.

5-73. Output Amplifier Adjustments.

5-74. The following adjustments set the bias and gain of the Output Amplifier (A12A8).

REQUIRED TEST EQUIPMENT:

AC Voltmeter (-hp- Model 427A)

DC Voltmeter (-hp- Model 412A)

a. Set the 745A frequency to 1 kHz on the X1K FREQUENCY RANGE.

b. Connect ac voltmeter to A12A8TP1.

c. Adjust A12A8R32 (38) for an indication of 0.1 V rms on the ac voltmeter.

d. Connect dc voltmeter to A2TP4 (Figure 5-32).

e. Adjust A12A6R4 (34) for an indication of -1 V ± 0.1 Vdc on the dc voltmeter.

f. Connect dc voltmeter to A12A8TP2.

NOTE

Although the dc level is not extremely critical, the polarity of the dc bias at A12A8TP2 *must* be positive. A negative dc level can cause breakdown of A12A8C16 and further produce oscillations and/or crossover distortion in the Preamplifier (A4) and Power Amplifier (A5). Since the stages in the Output Amplifier are direct-coupled, an unbalance in the Modulator (A12A7) can produce a dc offset at A12A8TP1 and further affect the bias at A12A8TP2. If the dc bias at TP2 is not within +0.2 V to +0.3 V, recheck the dc voltage at A12A8TP1 (0 V ± 2 mVdc) to verify correct Modulator balance.

g. Adjust A12A8R15 (36) for an indication of +0.3 V ± 0.05 Vdc on the dc voltmeter.

5-75. Frequency Divider Adjustments.

5-76. The following adjustments set the operating levels of Decade Frequency Dividers (A12A2 through A12A4).

REQUIRED TEST EQUIPMENT:

Oscilloscope (-hp- Model 180A)

a. Place A12A2 on a printed circuit board extender.

b. Connect oscilloscope to A12A2TP1. Set time base to 0.5 μSec/cm.

c. Adjust A12A2T1 (33) for maximum amplitude of the ac signal displayed on the oscilloscope (Figure 5-11).

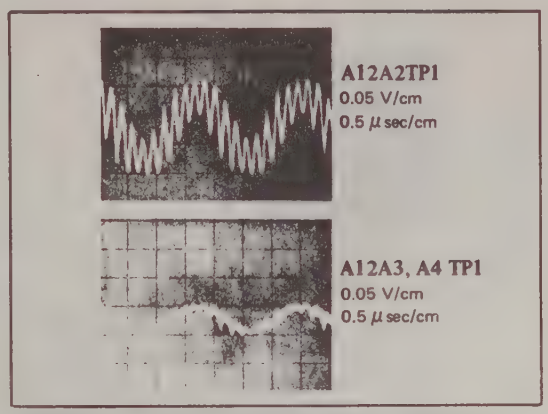


Figure 5-11. Decade Frequency Divider Adjustment

d. Set the 745A frequency to 10 kHz (X10K FREQUENCY RANGE).

e. Connect oscilloscope to A12A2TP2. Set time base to 0.1 μSec/cm.

f. Adjust A12A2C11 (28) and C18 (29) for maximum amplitude of the ac signal displayed on the oscilloscope.

g. Set the 745A frequency to 110 kHz.

h. Adjust A12A2C14 (27) for maximum signal amplitude.

i. Reset the 745A frequency to 10 kHz (X10K FREQUENCY RANGE).

j. Readjust A12A2C11 (28) for maximum signal amplitude.

k. While observing the oscilloscope, vary the 745A frequency setting from 10 kHz to 110 kHz. Signal amplitude at both ends of the FREQUENCY scale should be nearly equal. Adjust A12A2C18 (29) until the signal amplitude at 10 kHz is equal to the signal amplitude at 110 kHz.

l. Repeat Steps f through k as necessary to obtain optimum adjustment. Optimum adjustment is obtained when the signal at A12A2TP2 (Figure 5-12) is 0.7 V p-p or greater, at all frequency settings within the range of 10 kHz to 110 kHz.

m. Replace A12A2 in the A12 Assembly. Place A12A3 on a printed circuit board extender.

NOTE

The adjustment procedures for A12A3

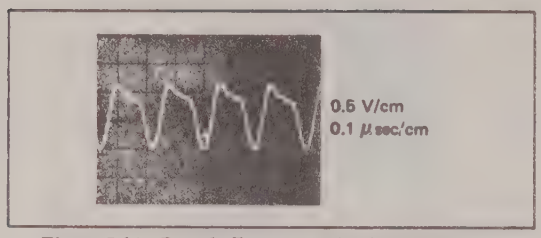


Figure 5-12. Decade Frequency divider adjustment (A12A2, A3, A4 TP2)

and A12A4 are identical. Perform Steps n through r for A12A3 adjustments then place A12A4 on a printed circuit board extender and repeat Steps n through r for the A12A4 adjustments.

n. Connect oscilloscope to TP1.

o. Adjust T1 (25) for maximum signal amplitude (Figure 5-11).

p. Set the 745A frequency to 55 kHz.

q. Connect oscilloscope to TP2.

r. Adjust C11 (28), C14 (27), and C18 (26) for maximum signal amplitude (Figure 5-12)

5-77. 100 kHz RESPONSE AND 100 V ACCURACY ADJUSTMENTS.

5-78. The purpose of the following adjustments is to set the 745A output voltage accuracy at 1 V, 100 kHz, at 10 V, 100 kHz and at 100 V, 1 kHz and 100 kHz. If desired, these adjustments can be performed as part of the 1 V, 10 V and 100 V Accuracy and Load Regulation Checks (Paragraph 5-22 and 5-24). The same test arrangement is required for both the accuracy checks and the adjustment procedures.

NOTE

A thermal transfer voltmeter is recommended for the following adjustment procedure. If a thermal transfer voltmeter is not available, refer to Paragraph 5-79 for the alternate procedure requiring 1 V, 10 V and 100 V thermal converters.

REQUIRED TEST EQUIPMENT:

Thermal Transfer Voltmeter (Holt Model 6* or Model 6A)

* Holt Model 6 requires an external dc null voltmeter (-hp- Model 419A).

DC Standard (-hp- Model 740B)

a. Set the thermal transfer voltmeter controls as follows:

FUNCTION ..... STDBY
VOLTAGE RANGE ..... 1 V
SENSITIVITY ..... SEARCH COARSE

b. Connect test equipment as shown in Figure 5-13.

c. Set the dc standard for an output of 1 volt (0.999999 V, 1 V range).

d. Set the 745A controls as follows:

VOLTAGE RANGE ..... 1 V
VOLTAGE Setting ..... 1.000000 V
FREQUENCY Scale 10.0
FREQUENCY RANGE ..... X10K (100 kHz)
ERROR RANGE 0
SENSE ..... REMOTE

e. Set the thermal transfer voltmeter FUNCTION to DC.

f. Adjust the thermal transfer voltmeter SEARCH and COARSE controls for a zero reading on the null meter.

g. Allow an initial warmup period of at least thirty minutes before proceeding with the adjustment procedure.

h. Increase the thermal transfer voltmeter SENSITIVITY and adjust the MEDIUM and FINE BALANCE controls for a zero indication on the null meter.

NOTE

If an external dc null voltmeter is used, the fine dc balance adjustments and ac measurement should be performed with the dc null voltmeter set to the voltage range that will provide optimum resolution (10 μV range).

i. Set the thermal transfer voltmeter FUNCTION to AC.

j. Adjust A3C12 (13) for a zero reading on the null meter.

k. Set the thermal transfer voltmeter FUNCTION to DC and (if necessary) readjust the FINE BALANCE control for a zero reading on the null meter.

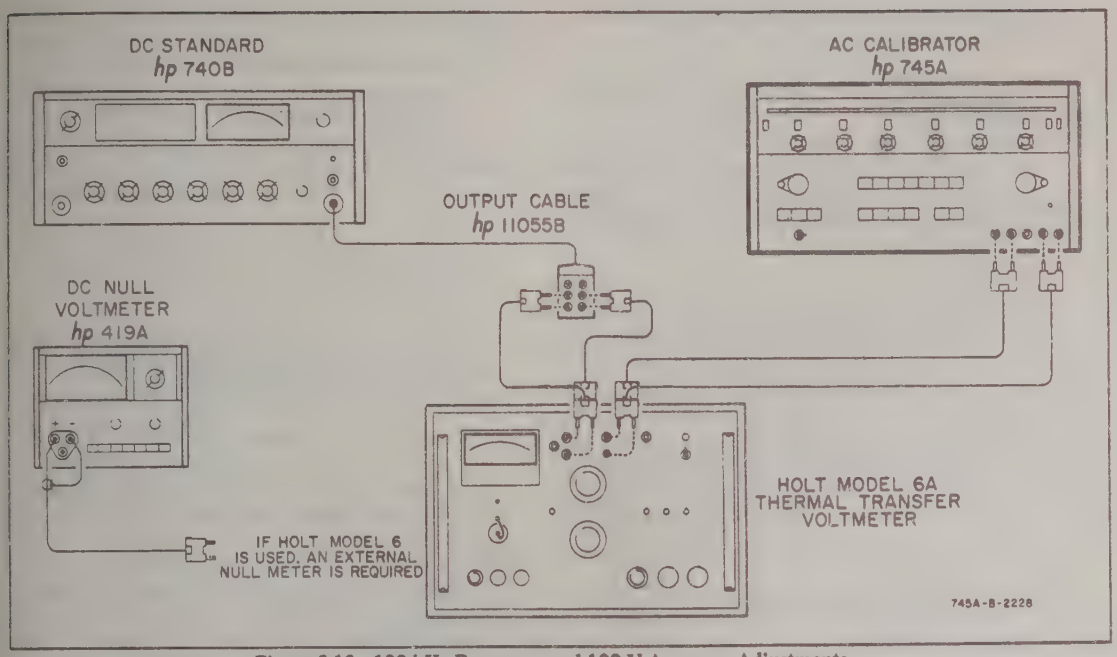


Figure 5-13. 100 kHz Response and 100 V Accuracy Adjustments

l. Repeat Steps i through k at least twice to obtain optimum adjustment and to minimize errors due to drift or technique.

m. Set the 745A and test equipment controls as follows:

Thermal Transfer Voltmeter:
FUNCTION ..... STDBY
VOLTAGE RANGE ..... 10 V
SENSITIVITY ..... SEARCH COARSE

DC Standard:
10 volts (9.99999 V, 10 V range)

745A:
VOLTAGE RANGE ..... 10 V
Voltage Setting ..... 10.00000 V
Frequency ..... 100 kHz
ERROR RANGE 0
SENSE ..... REMOTE

n. Perform Steps e through h (disregard Step g), then proceed to Step o.

o. Set the thermal transfer voltmeter FUNCTION to AC.

p. Adjust A6R16 (16) for a zero reading on the null meter.

q. Set the thermal transfer voltmeter FUNCTION to DC and (if necessary) readjust the FINE BALANCE control for a zero reading on the null meter.

r. Repeat Steps o through q at least twice to obtain optimum adjustment and to minimize errors due to drift or technique.

s. Set the 745A and test equipment controls as follows:

Thermal Transfer Voltmeter:
FUNCTION ..... STDBY
VOLTAGE RANGE ..... 100 V
SENSITIVITY ..... SEARCH COARSE

DC Standard:
100 Volts (99.9999 V, 100 V range)

745A:
VOLTAGE RANGE ..... 100 V
Voltage Setting ..... 100.0000 V
Frequency ..... 1 kHz
ERROR RANGE 0
SENSE ..... REMOTE

t. Perform Steps e through h (disregard Step g), then proceed to Step u.

u. Set the thermal transfer voltmeter FUNCTION to AC.

v. Adjust A14R7 (17) for a zero reading on the null meter.

w. Set the thermal transfer voltmeter FUNCTION to DC and (if necessary) readjust the FINE BALANCE CONTROL for a zero reading on the null meter.

x. Set the 745A frequency to 100 kHz. Set the thermal transfer voltmeter FUNCTION to AC.

y. Adjust C9 (18) for a zero reading on the null meter.

z. Set the thermal transfer voltmeter FUNCTION to DC and (if necessary) readjust the FINE BALANCE control for a zero reading on the null meter.

aa. Repeat Steps u through z at least twice to obtain optimum adjustment and to minimize errors due to drift or technique.

5-79. 100 kHz Response and 100 V Accuracy Adjustments (Alternate Procedure).

REQUIRED TEST EQUIPMENT:

1 V, 10 V and 100 V Thermal Converters (Englehard 36850)

DC Standard (-hp- Model 740B)

DC Differential Voltmeter (-hp- Model 3420A/B)

a. Connect test equipment as shown in Figure 5-14.

b. Set the 745A controls as follows:

VOLTAGE RANGE .....1 V
Voltage Setting .....1.000000 V
FREQUENCY RANGE X1K
Frequency Scale .....1.0 (1 kHz)
ERROR RANGE 0
SENSE .....REMOTE

c. Allow a warmup period of at least 15 minutes before proceeding.

d. Measure the thermal converter output voltage using the dc differential voltmeter. Record the dc differential voltmeter reading: ____V.

e. Set the 745A frequency to 100 kHz.

f. Adjust A3C12 (18) until the dc differential voltmeter indicates the exact value recorded in Step d.

g. Reset the 745A frequency to 1 kHz. Repeat Steps d through f.

h. Replace the 1 V thermal converter with a 10 V thermal converter.

i. Set the 745A controls as follows:

VOLTAGE RANGE .....10 V
Voltage Setting .....10.00000 V
FREQUENCY RANGE X1K
FREQUENCY Scale .....1.0 (1 kHz)
ERROR RANGE 0
SENSE .....REMOTE

j. Allow a warmup period of at least 15 minutes before proceeding.

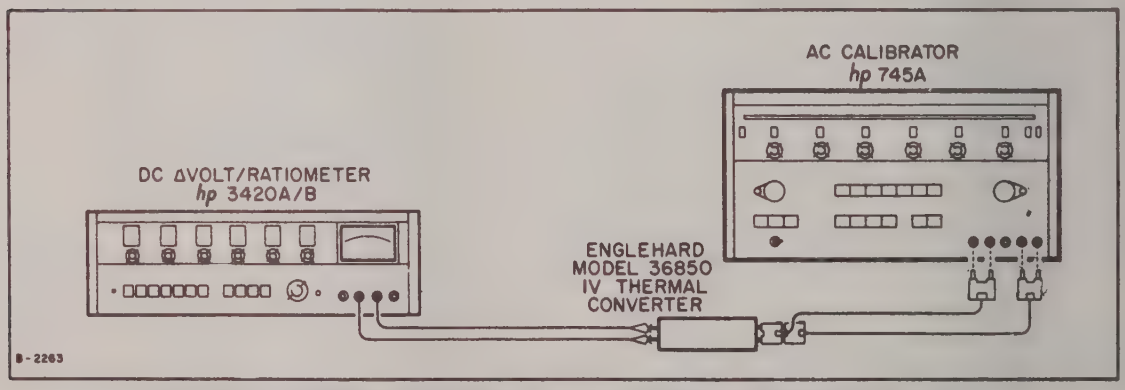


Figure 5-14. 100 kHz Response and 100 V Accuracy Adjustments (Alternate Procedure)

k. Measure the thermal converter output voltage using the dc differential voltmeter. Record the dc differential voltmeter reading:____V.

l. Set the 745A frequency to 100 kHz.

m. Adjust A6R16 (16) until the dc differential voltmeter indicates the exact value recorded in Step k.

n. Reset the 745A frequency to 1 kHz. Repeat Steps k through m.

o. Replace the 10 V thermal converter with a 100 V thermal converter. Connect the output of the dc standard to the input of the thermal converter as shown in Figure 5-5.

p. Set the dc standard for an output of 100 volts (99.9999 V, 100 V range).

q. Allow a warmup period of at least 15 minutes before proceeding.

r. Measure the thermal converter output voltage using the dc differential voltmeter. Record the dc differential voltmeter reading:____V.

s. Reverse the polarity of the connections to the thermal converter from the dc standard. Do not disturb the dc standard or dc differential voltmeter control settings.

t. Record the dc differential voltmeter reading: ____V.

u. Calculate and record the average value of the readings recorded in Steps r and t: ____V.

v. Without disturbing the voltage setting, disconnect the dc standard. Connect the 745A OUTPUT and SENSE leads to the input of the thermal converter.

w. Set the 745A controls as follows:

VOLTAGE RANGE .....100 V
Voltage Setting ..... 100.0000 V
FREQUENCY RANGE X1K
FREQUENCY Scale .....1.0 (1 kHz)
ERROR RANGE 0
SENSE .....REMOTE

x. Adjust A14R7 (17) until the dc differential voltmeter indicates the exact value recorded in Step u.

y Set the 745A frequency to 100 kHz. Adjust C9 (18) until the dc differential voltmeter indicates the exact value recorded in Step u.

z. Disconnect the 745A. Reconnect the dc standard to the input of the thermal converter. Repeat Steps r through y.

5-80. FREQUENCY SCALE TRACKING ADJUSTMENTS.

5-81. The purpose of the following adjustments is to set the 745A output frequency to correspond with the indications on the FREQUENCY scale. These adjustments should be performed if the 745A frequency scale accuracy is out of tolerance (Paragraph 5-9), after a repair in the A12A1 (VFO) subassembly or following removal and replacement of the Oscillator Assembly (A12). These adjustments may also be performed periodically as part of the routine maintainence for the Model 745A.

REQUIRED TEST EQUIPMENT:

Electronic Counter (-hp- Model 5216A)

NOTE

The following procedure should be performed with the oscillator cover fastened securely in place. Use an insulated tuning wand for the tracking adjustments.

a. Connect electronic counter to rear panel COUNTER OUTPUT connector.

b. Set the 745A FREQUENCY RANGE to X10K and adjust the FREQUENCY control for an indication of 1.0 on the FREQUENCY scale (10 kHz).

c. Adjust A12C2 (34) for an indication of 10.00 kHz on the electronic counter.

d. Rotate the FREQUENCY control slowly clockwise while observing the counter indication. If the output frequency *increases*, proceed to Step h. If the output frequency *decreases*, proceed to Step e.

NOTE

Since two closely spaced VFO frequencies (545 kHz and 565 kHz) will both produce an output frequency of 10 kHz, Steps d through g are necessary to ensure the proper frequency has been selected.

e. Readjust the 745A FREQUENCY control for an indication of 1.0 on the FREQUENCY scale (10 kHz).

f. While observing the counter indication, adjust A12C2 (24) until a second 10 kHz output frequency is obtained. If a second 10 kHz cannot be reached by adjusting A12C2, readjust A12C2 (24) for the original 10 kHz frequency indication. While observing the counter indication, adjust A12L1 (23) in the direction that causes the output frequency to decrease, pass through 0 Hz and increase to 10 kHz. Adjust A12L1 (23) for an indication of 10 kHz on the electronic counter.

g. Repeat Steps c and d.

h. Adjust the 745A FREQUENCY control for an indication of 10.0 on the FREQUENCY scale (100 kHz). Note the counter indication:____kHz.

i. Refer to Table 5-8. In the column headed "Counter Indication", locate the frequency that is nearest the frequency noted in Step h. Locate and note the frequency on the same horizontal line in the column headed "Set L1 to Obtain":____kHz.

j. Adjust A12L1 (23) for the counter indication noted in Step i.

k. Rotate the FREQUENCY control counterclockwise to 10 kHz while observing the counter indication to ensure that the output frequency does not pass through 0 Hz. If the output frequency passes through 0 Hz, repeat Steps c through j.

l. Adjust the 745A FREQUENCY control for an indication of 1.0 on the FREQUENCY scale. Adjust A12C2 (24) for an indication of 10.00 kHz on the electronic counter.

m. Repeat Steps h through l until the counter indications are within ± 1% of the 10 kHz and 100 kHz FREQUENCY scale settings.

n. Perform the Frequency Scale Accuracy Checks (Paragraph 5-9). If the 745A does not meet the frequency accuracy specifications on the X10K FREQUENCY RANGE with the 10 kHz and 100 kHz end-scale settings properly adjusted, refer to the supplement tracking procedure (Paragraph 5-82). If the 745A does not meet the frequency accuracy specifications on any one of the lower FREQUENCY RANGES (X10 through X1K), and the specifications are met on the X10K FREQUENCY RANGE, perform the Frequency Divider Adjustment procedure (Paragraph 5-75).

5-82. Mechanical Alignment and Frequency Tracking Adjustments.

5-83. The purpose of the following procedure is to supplement the Frequency Scale Tracking Adjustment (Paragraph 5-80). Included in the procedure are instructions for mechanically aligning and tracking the frequency tuning capacitor (A12C1).

5-84. Mechanical alignment should not be required unless the original alignment has been disturbed. The most frequent causes of misalignment are:

a. Slippage due to loose set screws.

b. Removal and Replacement of the Oscillator Assembly.

c. Dial cord replacement.

Table 5-8. FREQUENCY Scale Tracking

COUNTER INDICATION (kHz)	SET A12L1 TO OBTAIN (kHz)
80	150
81	147
82	144
83	142
84	139
85	137
86	134
87	131
88	129
89	126
90	124
91	121
92	119
93	117
94	114
95	112
96	109
97	107
98	104.6
99	102.3
100	100
101	97.69
102	95.41
103	93.2
104	90.9
105	88.7
106	86.4
107	84.1
108	82.1
109	79.9
110	77.8
111	75.6
112	73.5
113	71.4
114	69.3
115	67.2
116	65.1
117	63.1
118	61.0
119	59.0

5-85. The mechanical tracking adjustments (Steps q through w) consist of bending the outer plates of the tuning capacitor to obtain the specified frequency scale accuracy. These adjustments should be performed *only if* the 745A does not meet the frequency accuracy specifications on the X10K FREQUENCY RANGE with the 10 kHz and 100 kHz end-scale settings properly adjusted (Paragraph 5-80). If the end-scale settings cannot be set correctly, check the mechanical alignment (Steps a through p) or refer to the troubleshooting section.

REQUIRED TEST EQUIPMENT:

Electronic Counter (-hp- Model 5216A).

Alignment Tool: Use a flat piece of plastic or sheet metal approximately 1/2 inch wideand 1-3/4 inches long.

NOTE

If the frequency tuning capacitor (A12C1) is obviously misaligned, perform Steps a and b then proceed to Step h.

a. Turn the instrument off.

b. Place the instrument on its side. Remove the bottom covers and the Oscillator Assembly cover.

c. Adjust the FREQUENCY control for an indication of 11 on the FREQUENCY scale.

d. Place the alignment tool across the stator supports of the tuning capacitor as shown in Figure 5-15.

e. While holding the alignment tool firmly in place, rotate the FREQUENCY control slowly counterclockwise until the edges of the rotor plates lightly touch the alignment tool.

f. With the edges of the rotor plates lightly touching the alignment tool, the indication on the FREQUENCY scale should be between 9.55 and 9.75.

g. If the FREQUENCY scale indication (Step f) is correct, proceed to Step o. If the indication is incorrect, proceed to Step h.

h. Loosen both set screws that fasten the drive drum to the shaft of the tuning capacitor.

i. Adjust the tuning capacitor so the plates are fully meshed.

j. Place the alignment tool across the stator supports as shown in Figure 5-15.

k. Adjust the tuning capacitor until the edges of the rotor plates lightly touch the alignment tool.

l. While holding the alignment tool and rotor plates in position, adjust the FREQUENCY control for an indication between 9.6 and 9.7 on the FREQUENCY scale.

m. While continuing to hold the alignment tool and rotor plates in position, tighten one of the set screws enough to prevent slippage when the dial is rotated. Do not over tighten.

NOTE

When the set screw (Step m) is initially tightened, the rotor may slip slightly in either direction due to the original indentations in the capacitor shaft. Allow this slippage to occur the first time alignment is attempted. Repeat Steps c through g to determine if alignment is correct. If the alignment is not correct, repeat Step h through n. Attempt to hold the rotor in position (Step m) while tightening the set screw.

n. Repeat Steps c through g to determine if the alignment is correct. If alignment is correct, tighten both set screws and proceed to Step o. If alignment is not correct, repeat Steps h through n.

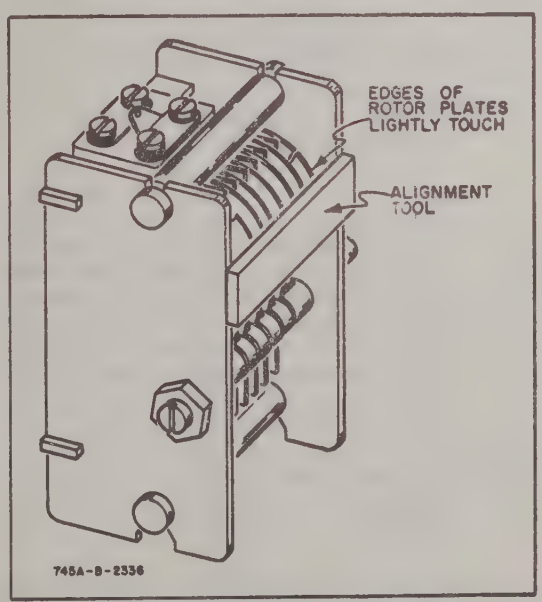


Figure 5-15. Frequency Scale Alignment

Table 5-9. Mechanical Tracking Adjustments

DIAL SETTING	TOLERANCES
1.0	9.8 kHz to 10.2 kHz
2.0	19.6 kHz to 20.4 kHz
3.0	29.4 kHz to 30.6 kHz
4.0	39.2 kHz to 40.8 kHz
5.0	49.0 kHz to 51.0 kHz
6.0	58.8 kHz to 61.2 kHz
7.0	68.6 kHz to 71.4 kHz
8.0	78.4 kHz to 81.6 kHz
9.0	98.2 kHz to 91.8 kHz
10.0	98.0 kHz to 102 kHz

o. Repeat the Frequency Scale Tracking adjustments as outlined in Paragraph 5-80. (Leave the Oscillator cover removed.)

p. Perform the Frequency Scale Accuracy Checks as outlined in Paragraph 5-9. If the frequency scale accuracy is within specified toelrances, replace the Oscillator cover and repeat the Frequency Scale Tracking Adjustments (Paragraph 5-80). If the frequency scale accuracy is out of tolerance with the 10 kHz and 100 kHz end-scale settings properly adjusted, proceed to Step q.

q. Connect the input of the electronic counter to the rear panel COUNTER OUTPUT connector.

r. Set the 745A FREQUENCY RANGE to X10K.

s. Adjust the FREQUENCY control for an indication of 1.0 on the FREQUENCY scale (10 kHz).

t. Adjust A12C2 (2) for an indication of 10.00 kHz on the electronic counter.

u. Set the 745A FREQUENCY dial to each setting listed in Table 5-9. At each dial setting, observe the counter indication. If the 745A output frequency is not within the tolerance listed in Table 5-9, bend the outer plate of the tuning capacitor at the point shown in Figure 5-16. Bending a plate inward will increase the frequency; bending outward will decrease the frequency. Bend the plate only enough to bring the output frequency to within ± 1% of the frequency setting.

v. Repeat the Frequency Scale Tracking Adjustments (Paragraph 5-80). (Leave the Oscillator cover removed.)

w. Set the 745A FREQUENCY dial to each setting listed in Table 5-9. At each frequency setting, observe the counter indication and verify that the output frequency is within the tolerances listed in the table.

x. If any of the frequency settings are not within the listed tolerances, repeat Steps u through w. If all settings are in-tolerance, replace the Oscillator cover and repeat the Frequency Scale Tracking Adjustments (Paragraph 5-80).

5-86. ERROR SCALE ZERO ADJUSTMENT.

5-87. The purpose of the following adjustment is to zero set the error measurement potentiometer (R1). This adjustment should be performed *only if* the 745A fails to meet the error measurement accuracy specifications (Paragraph 5-18), or if the mechanical alignment of the error potentiometer has been disturbed.

NOTE

The purpose of Steps h and i in the following procedure is to determine the necessity of the mechanical zero adjustment. If the error potentiometer is obviously misaligned (due to slippage, replacement, etc.), perform Steps a through g then proceed to Step j.

REQUIRED TEST EQUIPMENT:

DC Differential Voltmeter (-hp- Model 3420A/B)

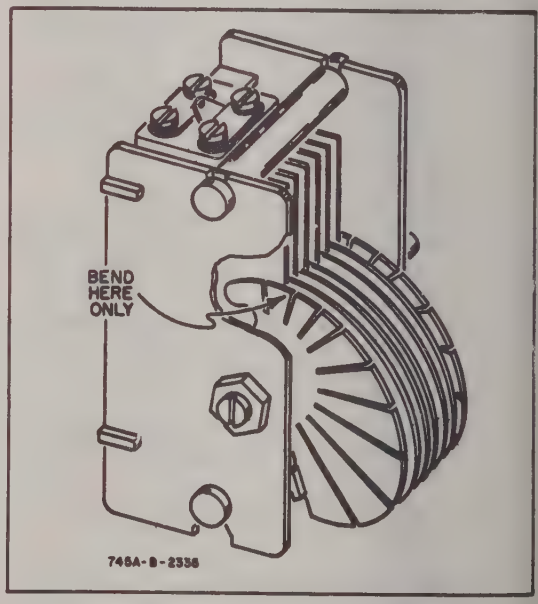


Figure 5-16. Frequency Scale Tracking

a. Remove the top and bottom covers (outer and inner covers).

b. Place the instrument on it's side to permit access to both the Reference Assembly (A1) and the chain drive for the error potentiometer. Turn the instrument on and allow a warmup period of at least 30 minutes before proceeding.

c. Set A1A4S1 to the + 9.9 V position.

d. Set the dc differential voltmeter to measure + 9.9 Vdc.

e. Connect the dc differential voltmeter to A1A3TP5.

f. Select the 0 ERROR RANGE and adjust the ERROR MEASUREMENT control for an indication of 0 on the % ERROR scale.

g. Record the dc differential voltmeter reading: _ __V.

h. Select the X1 ERROR RANGE. The dc differential voltmeter reading should not vary more than ± 50μV from the value recorded in Step g.

i. If the indication (Step h) is *incorrect*, proceed to Step j. If the indication is correct, repeat the Error Measurement Accuracy Check (Paragraph 5-18). If the error measurement accuracy is out of tolerance, refer to Paragraph 5-88.

NOTE

Before proceeding with the mechanical zero adjustment, check the tension of the drive chain that runs from the shaft of the ERROR MEASUREMENT control to the error measurement potentiometer. Tension should be adjusted so the shaft of the error potentiometer moves with the slightest movement of the ERROR MEASUREMENT control, but loose enough to permit the control to operate smoothly.

j. Loosen the two set screws that fasten the drive sprocket to the shaft of the error potentiometer.

k. Using a pair of long-nosed pliers, rotate the shaft of the error potentiometer until the dc differential voltmeter indicates the exact value recorded in Step g.

l. While holding the shaft of the error potentiometer, adjust the ERROR MEASUREMENT control for an exact indication of 0 on the % ERROR scale.

m. Repeat Steps k and l as necessary to obtain optimum adjustment.

NOTE

When the set screw (Step n) is initially tightened, the setting may vary slightly due to previous indentations in the shaft of the error potentiometer. If, for this reason, correct adjustment cannot be obtained, loosen the drive chain and rotate the drive sprocket to a different position on the control shaft.

n. Carefully retighten one of the set screws tight enough to prevent slippage when the ERROR MEASUREMENT control is rotated. Do not over tighten.

o. Rotate the ERROR MEASUREMENT control fully clockwise, fully counterclockwise and back to zero.

p. Adjust the ERROR MEASUREMENT control for an exact indication of 0 on the % ERROR scale. The dc differential voltmeter should indicate the value recorded in Step g ± 50 μV.

q. If the indication (Step p) is incorrect, repeat Steps j through p. If the indication is correct, retighten both set screws, repeat Steps o and p to double check the zero setting and repeat the Error Measurement Accuracy Check (Paragraph 5-18). If the error measurement accuracy is out of tolerance, refer to Paragraph 5-88.

5-88. Tracking Adjustment.

5-89. The purpose of the tracking adjustment is to set the error measurement accuracy to within ± 0.5% of end scale on the X1 ERROR RANGE. This adjustment should be performed *only if* one of the following conditions exist:

1. If the error measurement potentiometer (R1) has been replaced.

2. If the error measurement accuracy (Paragraph 5-18) is out of tolerance on the X1 ERROR RANGE with the zero setting (Paragraph 5-86) properly adjusted.

If R1 has not been replaced or if the inaccuracy occurs on the X.1 ERROR RANGE only, check for the following possible malfunctions:

1. Shorted or resistive relays (A1A4K1 or A1A4K2) or other faulty components in the error measurement network (P/O A1A4 Schematic No. 4).

2. Leakage resistance between the rotor of R1 and circuit ground.

REQUIRED TEST EQUIPMENT:

AC Differential Voltmeter (Fluke Model 883AB)

AC Divider Transformer: (E.S.I. Model DT72A Dekatran)

Ohmmeter: (-hp- Model 412A)

Variable Resistor: 50 kilohms ± 10% 1 W met film 10 turn (-hp- Part No. 2100-1911)

a. Perform the Error Scale Zero Adjustment procedure outlined in Paragraph 5-87.

b. Turn the instrument off. Remove the padding resistor (R2) which is connected in parallel with the error measurement potentiometer (R1). (Refer to Figure 7-2 for locations).

c. Temporarily install a 50 kilohm 10-turn potentiometer in place of the padding resistor to provide a variable padding resistance. Adjust the potentiometer to mid-setting.

d. Turn the instrument on and allow a warmup period of at least thirty minutes before proceeding.

e. Connect the 745A OUTPUT and SENSE to the input (1.0) of the ac divider transformer. Connect the output of the ac divider transformer to the input of the ac differential voltmeter. (This setup is shown in Figure 5-3).

f. Set the ac differential voltmeter to measure 1 volt (0.99999 V, 1 V range). Set the ac divider controls to 1.0000000 (1:1 ratio).

g. Set the 745A controls as follows:

VOLTAGE RANGE .....1 V
Voltage Setting ..... 1.000000 V
Frequency .....1 kHz
ERROR RANGE 0
SENSE .....REMOTE

h. Record the ac differential voltmeter reading: ___V.

i. Set the ac divider controls to 0.9708740. Select the X1 ERROR RANGE and set the ERROR MEASUREMENT control for an indication of -3.0 on the % ERROR scale.

j. Adjust the variable padding resistor (Step c) until the ac differential voltmeter indicates the value recorded in Step h ± 0.00015 V.

k. Set the ac divider controls to 1.0309290. Set the ERROR MEASUREMENT control for an indication of + 3.0 on the % ERROR scale.

l. Adjust the variable padding resistor until the ac differential voltmeter indicates the value recorded in Step h ± 0.00015 V.

NOTE

In some cases, the error potentiometer will not require a padding resistor or will require a resistance greater than 50 kilohms. If the correct readings (Step m) are not within the range of the 50 K potentiometer, increase the padding resistance by adding a fixed resistor in series with the potentiometer. Increase the padding resistance as necessary to obtain the required value.

m. Repeat Steps i through l until the ac differential voltmeter readings (Steps j and l) are both within ± 0.00015 V of the value recorded in Step h. If correct adjustment cannot be obtained, recheck for the possible malfunctions listed at the beginning of this procedure or replace R1.

n. Turn the instrument off and remove the variable padding resistor. Be careful not to disturb the variable resistor setting.

o. Measure the set resistance of the variable padding resistor.

p. Replace R2 with a fixed metal film resistor (1/8 W ± 1%) that is within ± 5% of the resistance measured in Step o.

q. Repeat the Error Measurement Accuracy Check (Paragraph 5-18).

5-90. FACTORY SELECTED COMPONENTS.

5-91. Certain components within the 745A are individually selected at the factory to compensate for slightly varying circuit parameters. These components are identified by an asterisk (*) in the parts list and schematic diagrams and

Table 5-10. Factory-Selected Components

COMPONENT	FUNCTION	TYPICAL VALUE RANGE	SCHEMATIC NO.
A1A2A1R8*, R9*, R10* (series combination)	Adjusts −6 Vdc reference	100 Ω to 300 Ω	2
A2R21*	TC response below 100 Hz	200 ohms	5
A6C1*, A6C2* (parallel combination)	Adjusts mV range accuracy at 100 kHz. (Paragraph 5-32)	470 pF to 1300 pF	9
A12A2, A3, A4 C13*	Sets range of C14.	62 pF to 82 pF	15
A12A2, A3, A4 C19*	Sets range of C18.	62 pF to 82 pF	15
C2*	Adjusts basic accuracy on all voltage ranges. Increasing C2 by 100 pF will increase output voltage by approximately 0.002% at 1 V, 1 kHz	360 pF to 1300 pF (Do not exceed 1500 pF)	13
R2*	Adjusts % ERROR scale tracking. (Paragraph 5-88)	(9 K to 30 K nominal)	3

typical value is shown. Table 5-10 is a list of the factory selected components, their functions, typical value ranges and schematic numbers.

NOTE

It is normally unnecessary to change the values of the factory selected components unless otherwise indicated in the adjustment procedures.

5-92. CONDENSED ADJUSTMENT PROCEDURE.

5-93. The following procedure is provided for the convenience of those who regularly service the Model 745A and are basically familiar with the adjustment procedures. If you have not previously performed the adjustments, refer to the step-by-step adjustment procedures (Paragraph 5-33).

5-94. Power Supply and Bias Adjustments.

1. Refer to Figure 5-32 for locations.

2. Required Equipment:
   DC Voltmeter (-hp- Model 412A)
   Electronic Counter (-hp- Model 5216A)
   DC Differential Voltmeter (-hp- Model 3420A/B)

3. 745A Setting: 1.000000 mV, 1 kHz (X1K)

4. Adjust the following:

   a. ㉒ for −70 V ± 0.5 Vdc at A8TP3.

   b. ㉑ for + 70 V ± 0.5 Vdc at A8TP4.

   c. ⑳ for −25 V ± 0.2 Vdc at A8TP1.

   d. ⑲ for + 5.2 V ± 0.1 Vdc at A8TP2.

   e. ⑭ for 0 V ± 3 mVdc at A4TP1.

   f. ⑫ for 0 V ± 1 mVdc at A3TP1 (Freq. set to 50 kHz, A1A4S1 set to + 9.9 V).

   g. ⑪ for 500 mSec ± 50 mSec sample gate at A2 pin 12.

   h. ⑨ for 0 V ± 1 mVdc at A2TP1 (A3 removed).

   i. ⑨ for + 0.6 V ±0.05 Vdc at A2TP2 (A3 replaced).

   j. ⑩ for 0 V ± 0.1 mVdc at A2TP3.

   k. Check A2TP4 (X1K FREQ. RANGE) for −1 V ± 0.1 Vdc.

      (1) Adjust ⑱ (X100 FREQ. RANGE) for equal dc volts at A2TP4.

   l. ⑦ for 500 Hz ± 1 Hz at A1A3TP5.

   m. ⑤ and ⑥ for −9.9 V ± 10 μVdc at A1A3TP5 (A1A4S1 set to −9.9 V).

   n. ③ and ④ for + 9.9 V ±10 μVdc at A1A3TP5 (A1A4S1 set to + 9.9 V).

5-95. Oscillator Adjustments (Modulator Balance, AGC Level and Output Amplifier only).

1. Refer to Figure 5-33 for locations.

2. Required Equipment:
   AC Voltmeter (-hp- Model 427A)
   DC Voltmeter (-hp- Model 412A)

3. 745A Setting: 1.000000 mV, 1 kHz

4. Adjust the following:

   a. Check A12A8TP1 for 0 V ± 5 mVdc.

      (1) If within 0 V ± 5 mVdc, adjust (36) and (37) *slightly* for 0 V ± 2 mVdc.

      (2) If not within 0 V ± 5 mVdc, refer to Paragraph 5-71.

   b. (36) for +0.3 V ± 0.05 Vdc at A12A8TP2.

   c. (38) for 0.1 V rms at A12A8TP1.

   d. (34) for -1 V, ± 0.1 Vdc at A2TP4 (Figure 5-32).

5-96. 100 kHz Response and 100 V Accuracy.

1. Refer to Figure 5-32 for locations.

2. Adjust the following:

   a. (13) for optimum accuracy at 1 V, 100 kHz.

   b. (16) for optimum accuracy at 10 V, 100 kHz.

   c. (17) for optimum accuracy at 100 V, 1 kHz.

   d. (18) for optimum accuracy at 100 V, 100 kHz.

5-97. REMOVAL AND REPLACEMENT OF ASSEMBLIES AND COMPONENTS.

5-98. This portion of Section V contains instructions for removing and replacing various assemblies and components within the Model 745A.

5-99. LAMP REPLACEMENT.

5-100. A package containing 12 spare lamps (-hp- Part No. 1450-0356) for the front panel pushbuttons, 12 lamps (-hp- Part No. 2140-0246) for the Readout Assembly and a lamp extractor (-hp- Part No. 4040-0427) is supplied with the instrument. The package can be reached by removing the Top Trim (MP28, Figure 6-1).

5-101. Pushbutton Lamps.

a. Insert the extractor tool as shown in Figure 5-17. Hold the window with one hand until the lens pops out. If the pushbutton window should accidentally become disengaged, refer to the note at the end of this procedure.

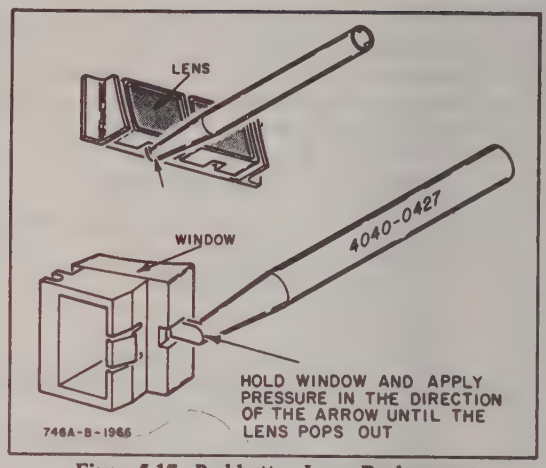


Figure 5-17. Pushbutton Lamp Replacement

b. Insert the rounded end of the tool through the pushbutton window opening and apply medium pressure to the lamp. Removing the extractor tool should remove the lamp from its socket.

c. To replace the lamp, insert the new lamp in the extractor in place of the burned-out lamp. Insert the lamp through the pushbutton window and into the lamp socket. Once the lamp is in its socket, twist the extractor while removing it from the pushbutton window.

d. To replace the lens, insert the top of the lens first and apply enough pressure to pop the lens into place.

NOTE

When reinstalling a pushbutton window or the Front Panel Logic Assembly (A13), it will be necessary to reposition the switch contact as shown in Figure 5-18. Failure to reposition the switch contact will cause the pushbutton switches to remain closed and further disable related switching circuits. To insure that the contact is properly positioned, refer to Figure 5-18. If it is not properly positioned, use a pointed object (soldering aid, etc.) to position the contact as illustrated in the figure. If the switch remains closed with the contact properly positioned, it will be necessary to bend the contact by inserting a hooked tool inside the contact fold and pulling outward.

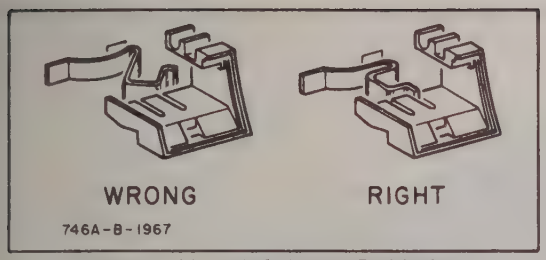


Figure 5-18. Switch Contact Positioning

5-102. Readout Lamps.

a. Remove the Lamp Assembly (A11A1) as shown in Figure 5-19.

b. Using a low-heat (25 to 30 watts) small-tip soldering iron, alternately heat the lamp connections (pads) while pulling the lamp out.

CAUTION

BE CAREFUL NOT TO OVERHEAT THE PC PADS ON THE A11A1 ASSEMBLY. EXCESSIVE HEAT WILL CAUSE THE PADS TO SEPARATE FROM THE BOARD.

c. If the lead holes are not open, melt a small amount of solder on the pad and clean holes using a desoldering tool.

d. Insert and solder the replacement lamp.

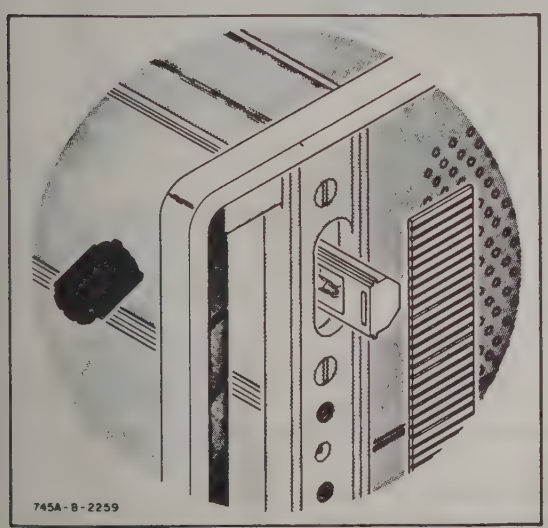


Figure 5-19. Readout Lamp Replacement

e. Check for solder bridges before reinstalling the A11A1 Assembly.

f. The -hp- Part Number for the A11A1 Assembly (including lamps) is 00745-66523.

5-103. COMPONENT REPLACEMENT.

5-104. The Model 745A contains 21 printed-circuit assemblies and four main flex-cables (W2 through W5). The -hp- part number is printed on each assembly and flex-cable. Refer to Section VI for parts replacement and -hp- part number information.

5-105. The printed-circuit boards are of the plated-through type. The electrical connection between the two sides of a board is made by a layer of metal plated through the component hole. When servicing the PC boards or flex-cables, observe the following guidelines:

a. Use a low-heat (25 to 30 watts) small-tip soldering iron, and small-diameter rosin core solder.

b. Remove components and clean component holes using a desoldering tool.

c. Do not overheat the PC connections (pads).

d. To replace components, shape new leads and insert them in lead holes. Reheat connections and apply a small amount of solder as required to insure a good electrical connection.

e. Clean excessive flux from the connection and adjoining area.

5-106. The following are additional guidelines for replacing specific components:

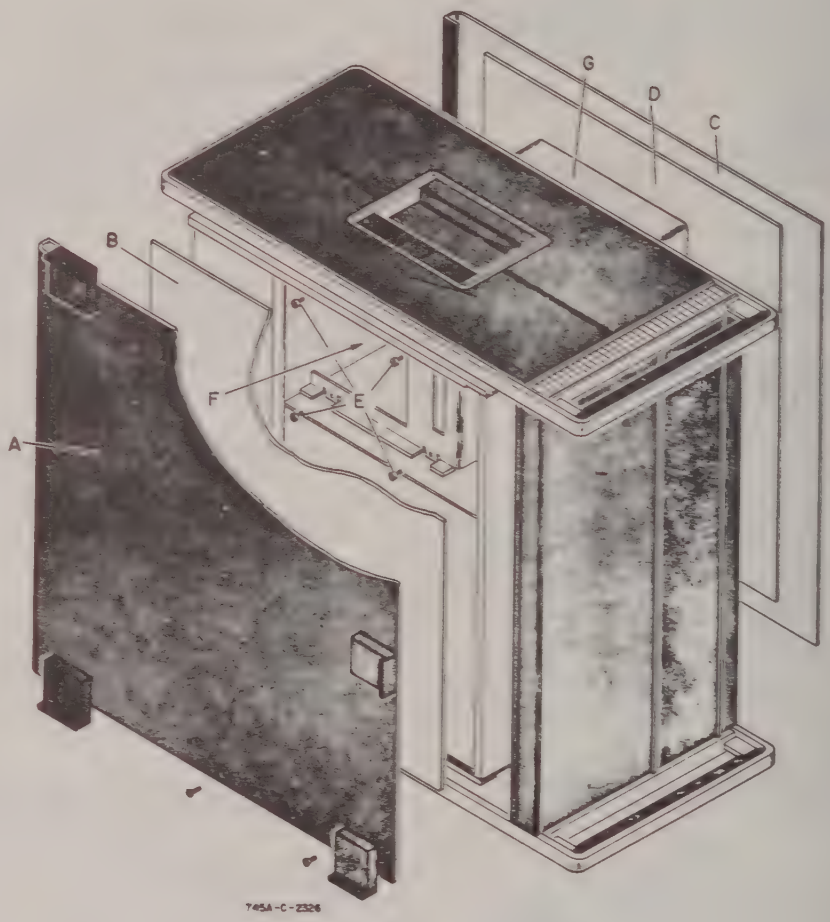
a. When replacing transistors (particularly FET's), note the lead configuration and position of the defective transistor. Orient the replacement transistor in the same manner as the original.

b. When replacing reed relays, avoid placing stress on the contact leads. Stress on the contact leads can cause intermittent and shorted contacts.

c. When replacing the thermocouple (A2TC1), scrape the leads of the replacement thermocouple to remove varnish and potting compound.

5-107. ASSEMBLY REMOVAL.

5-108. Figures 5-20 through 5-23 illustrate and describe the method for removing the four major assemblies within



A. Remove bottom outer cover.

B. Remove bottom inner cover.

C. Remove top outer cover.

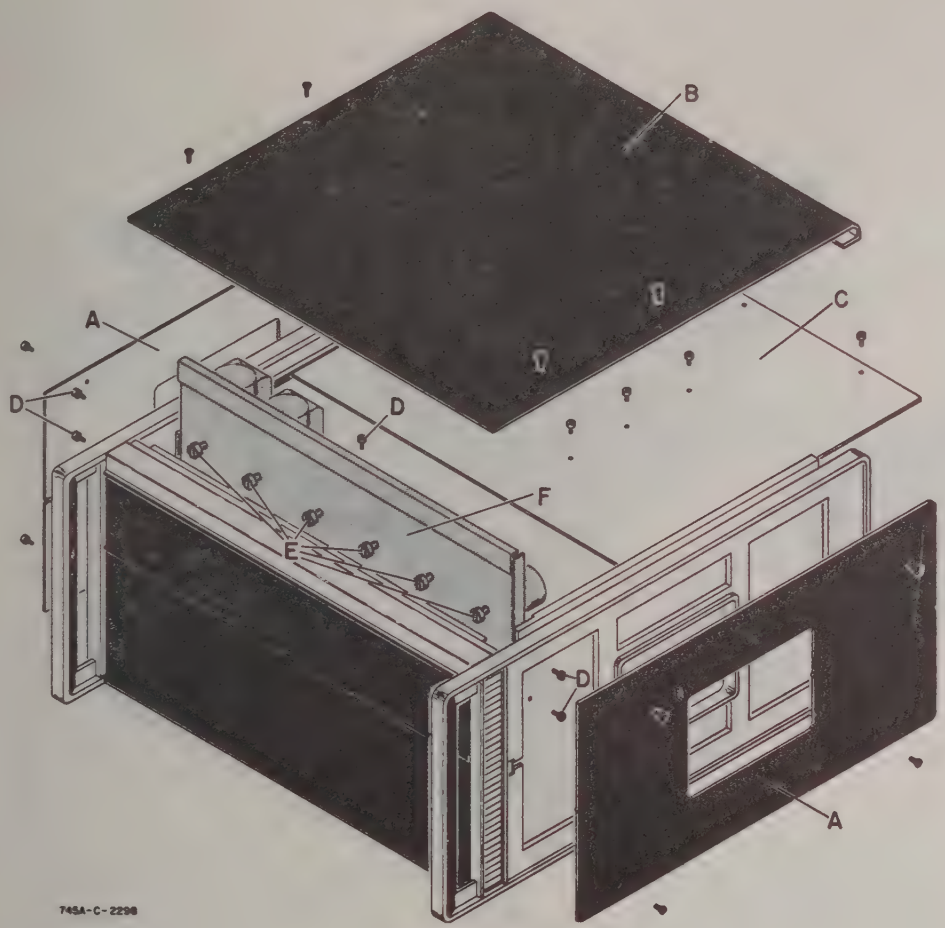
D. Remove top inner cover.

E. Remove four screws that fasten A1 Assembly to deck.

F. Push through opening in sheet metal to disengage A1 from the connector.

G. Remove A1 from the top of the instrument.

Figure 5-20. Reference Square Wave Generator (A1) Removal.



A. Remove left and right side covers.

B. Remove top outer cover.

C. Remove top inner cover.

D. Remove five screws that fasten A10 Assembly to sheet metal.

E. Rotate voltage-set controls (or decade switch shafts) fully counter-clockwise.

1. Disconnect P1, P2 and P4.

F. Lift A10 part of the way out to permit access to the PC plug (A10P1).

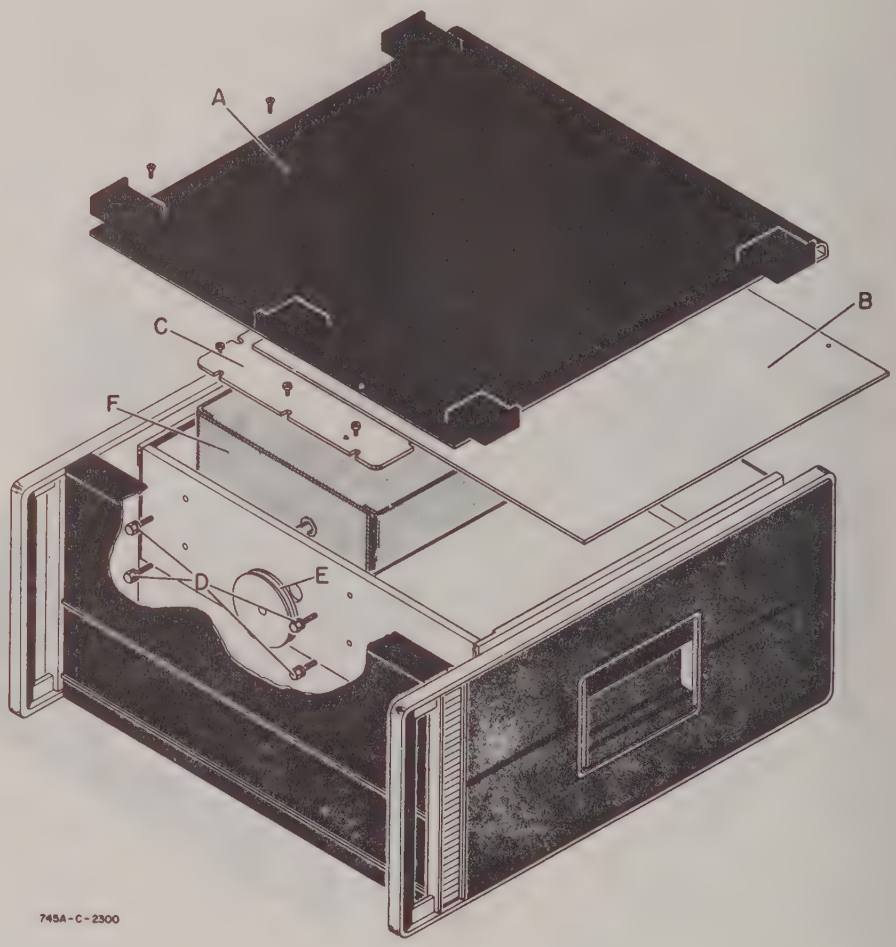
1. Disconnect A10P1.

2. Lift out A10.

NOTE

Before attempting to replace A10, set the voltage-set control shafts to the correct position and place the teflon insulators on the hub couplers of the control shafts.

Figure 5-21. Decade Assembly (A10) Removal.



A. Remove bottom outer cover.

B. Remove bottom inner cover.

C. Remove Oscillator Assembly cover.

D. Remove four bolts that fasten Oscillator Assembly to chassis.

1. Disconnect P3 (cable to COUNTER OUTPUT).

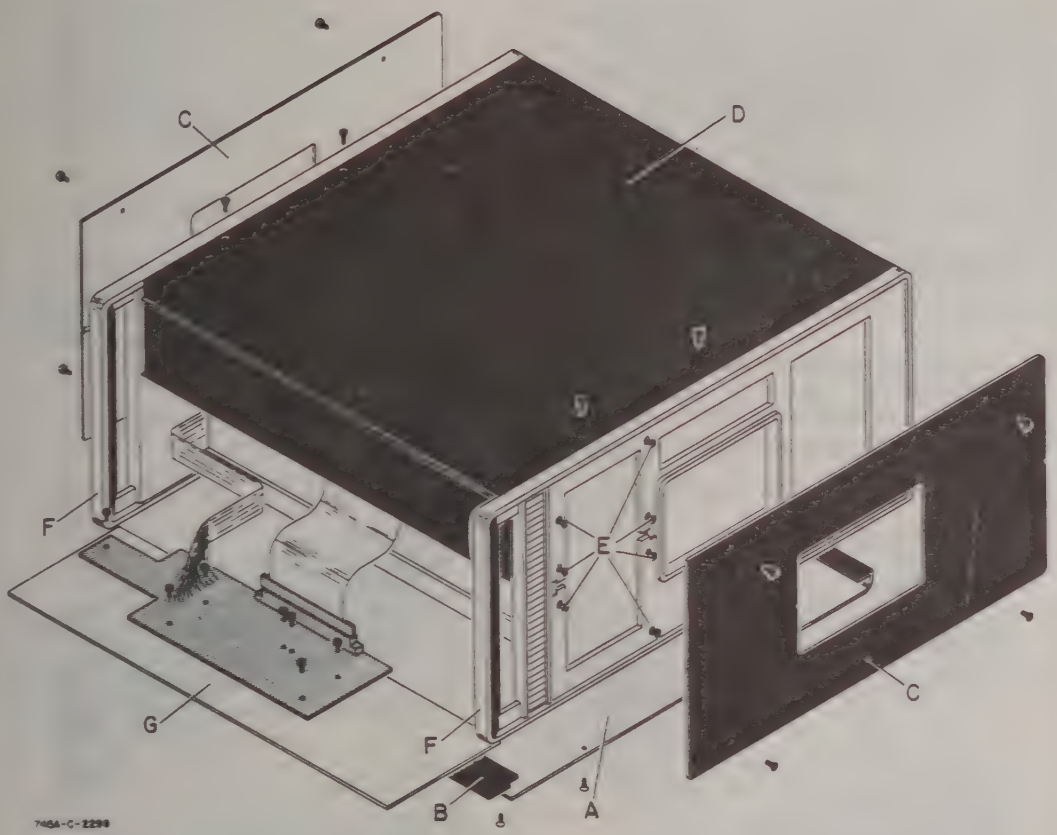
E. Loosen the two set screws and remove the drive drum. Maintain tension on the dial cord by taping the drum to the bottom trim.

F. Slide the Oscillator Assembly toward the rear panel to disengage the connector. Lift out the Oscillator Assembly.

NOTE

When replacing the Oscillator Assembly, refer to Paragraph 5-82 before tightening the set screws for the drive drum or replacing the Oscillator cover.

Figure 5-22. Oscillator Assembly (A12) Removal.



A. Remove bottom outer cover.

B. Remove bottom trim.

C. Remove left and right side covers.

D. Remove top outer cover.

1. Remove knob from ERROR MEASUREMENT control and FREQUENCY control.

E. Loosen (to approximately 3/4 of the way out) seven screws on each side frame.

F. Pull the side frames apart to disengage the front panel.

G. Carefully pull outward on the Front Panel Assembly allowing the panel to tilt toward you and rest on the bench with the rear of the panel facing upward.

H. To remove the Front Panel Logic Assembly (A13), disconnect the flex-cable (W2) and remove the seven screws shown in the drawing. Unless A13 is being replaced, it is not necessary to disconnect the ribbon cable. After A13 is reinstalled, it will be necessary to remove the lens from each of the pushbuttons (Figure 5-17) and reposition the switch contacts as shown in Figure 5-18.

Figure 5-23. Front Panel Removal

the Model 745A. The assemblies can be replaced by reversing the basic procedures outlined in the figures.

5-109. DIAL CORD REPLACEMENT.

5-110. The 745A contains a total of five dial cords, four of which are located in the Readout Assembly (A11). The dial cords in the Readout Assembly are used to drive the cursors for the FREQUENCY scale and % ERROR scale. The fifth dial cord is routed from the shaft of the FREQUENCY control to the drum that drives the frequency tuning capacitor. The dial cords are numbered 1 through 5 as shown in Figure 5-24. In order to gain access to cords 1 through 4 it is necessary to remove the front panel and partially dismantle the Readout Assembly (A11). Complete removal of A11 or A13 is not required. Dial cord 5 can be reached by removing the front panel (Figure 5-23).

5-111. The following procedures outline the steps required to replace dial cords 1 through 4 (Paragraph 5-112) and dial cord 5 (Paragraph 5-114). Refer to Figure 5-24 and determine the call-out number of the dial cord to be replaced. Study the drawings and the procedure carefully before proceeding.

CAUTION

USE ONLY 0.027 in. DIAMETER DACRON BRAID DIAL CORD (-hp- Part No. 8200-0049). DO NOT USE WAXED DIAL CORD. WAXED DIAL CORD WILL CAUSE INCORRECT DIAL TRACKING.

5-112. Replacing Cords 1 through 4

5-113. Steps a through g in the following procedure describe the mechanical disassembly that is required to gain access to dial cords 1 through 4. Refer to Figures 6-1 and 6-2 for the location of mechanical parts (MP) called out in the procedure.

a. Remove the front panel assembly as outlined in Figure 5-23 (Steps A through G only).

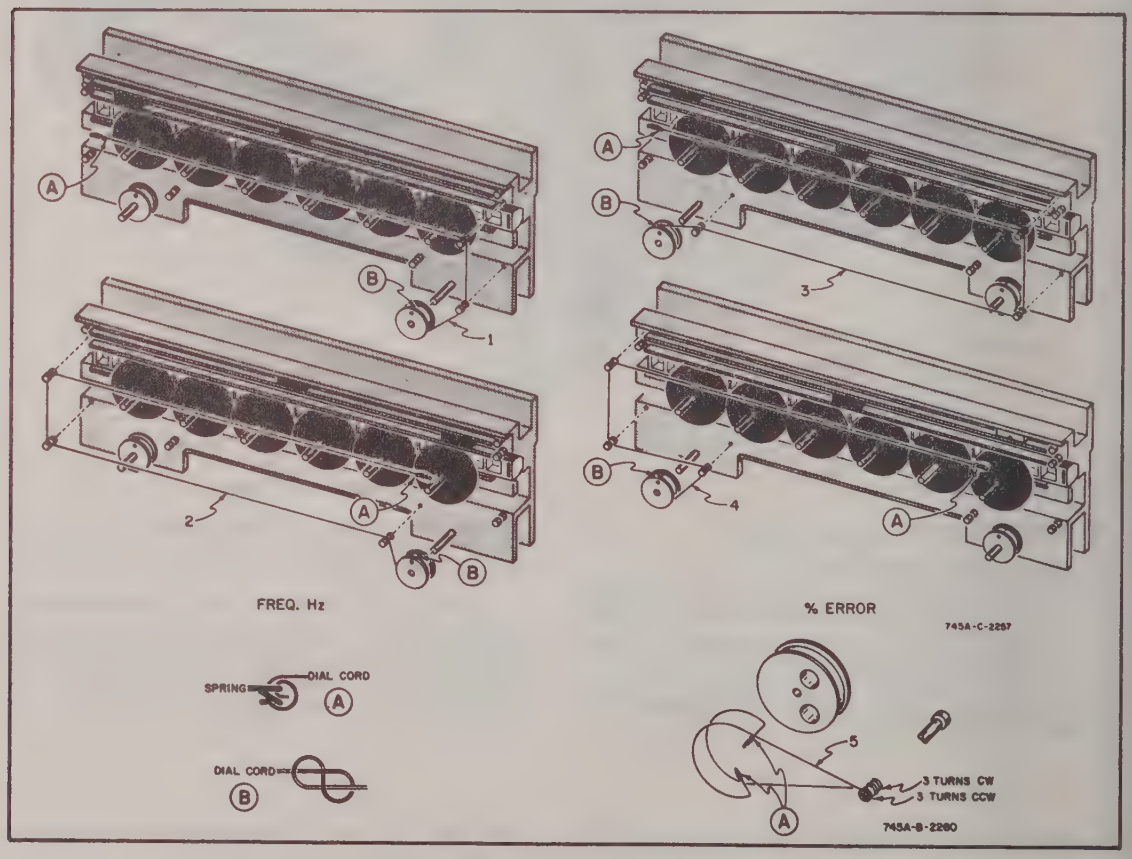


Figure 5-24. Dial Cord Replacement

b. Remove the knobs from the voltage-set controls.

c. Remove the top trim (MP28, Figure 6-1).

d. Remove the inside bottom trim (MP29, Figure 6-1) by removing the four screws on the front of the trim.

e. Pull the side frames apart and remove the plastic dial plate (MP26, Figure 6-1).

f. Remove the two screws that fasten the black back-plate to the frame of the Readout Assembly.

g. Remove the back plate. Be careful to disengage the two cursors that protrude through the slot in the back plate.

h. Temporarily install one of the voltage set control knobs on the shaft of the control with the broken dial cord.

i. Remove the plastic cursor that is connected to the broken dial cord. Leave one end of the cursor spring attached to the unbroken dial cord. There will be enough elasticity to permit reinstallation of the plastic cursor after the dial cord is replaced.

j. Remove the broken dial cord. Cut approximately 3 feet of new dial cord.

k. Refer to Figure 5-24 and determine the number of the dial cord to be replaced.

l. Rotate the control shaft fully counter clockwise (cords 1 and 4) or fully clockwise (cords 2 and 3). Maintain tension on the unbroken dial cord by holding the cursor spring when the control shaft is rotated.

m. Insert the new dial cord in the appropriate hole in the dial drum and out through the larger hole in the side of the drum. Tie a "figure 8" knot in the cord as shown in Figure 5-24 Point B. Tighten the knot securely and pull the unknotted end of the cord so the knot is inside the drum.

n. Route the cord as shown in Figure 5-24.

o. Tie the cord to the cursor spring as shown in Figure 5-24 Point A. Pull on the loose end of the cord to adjust tension. With the tension properly adjusted, the spring will be expanded to approximately 1/2 inch. The control shaft should rotate smoothly and the cursor spring should move with the slightest movement of the control shaft.

p. Reinstall the plastic cursor over the cursor spring. Be sure the plastic cursor does not slip when the control shaft is rotated.

q. Remove the voltage-set control knob from the control shaft.

r. Reassemble the Readout and reinstall the front panel by reversing the procedure outlined in Steps a through g.

s. If dial cord 1 or 2 was replaced, perform the Mechanical Alignment procedure outlined in Paragraph 5-82. If dial cord 3 or 4 was replaced, perform the Error Scale Zero Adjustment procedure outlined in Paragraph 5-86.

5-114. Replacing Cord 5 .

5-115. To replace dial cord 5 , proceed as follows:

a. Remove the front panel as outlined in Figure 5-23 (Steps A through G only).

b. Route new cord as shown in Figure 5-24.

c. Perform the Mechanical Alignment procedure outlined in Paragraph 5-82.

5-116. TROUBLESHOOTING.

5-117. This portion of the manual contains information and procedures designed to assist in the isolation of malfunctions. The information presented is based on a systematic analysis of the instrument circuits and on compiled failure data.

5-118. GUIDELINES.

5-119. Before troubleshooting the Model 745A, observe the following guidelines:

a. Obtain as many front panel symptoms as possible.

b. Monitor the 745A output and obtain the following failure information:

(1) Trouble appears on: _____
VOLTAGE RANGE(S).

(2) Trouble appears on: _____
FREQUENCY RANGE(S).

(3) Trouble appears at: _____
FREQUENCY dial settings.

(4) Trouble appears at: _____
voltage settings.

c. Perform the Power Supply and Bias Adjustments (Paragraph 5-44). Some apparent malfunctions can be corrected by these adjustments or the inability to obtain correct adjustment will often reveal the source of trouble. Symptoms such as output distortion or incorrect output frequency can usually be corrected by performing the Oscillator Adjustments (Paragraph 5-64) or the Frequency Scale Tracking Adjustments (Paragraph 5-80). Perform the 100 kHz Response and 100 V Accuracy Adjustments (Paragraph 5-77) if applicable.

d. Check the power supplies (Paragraph 5-133) before troubleshooting other sections.

e. Check for burned or loose components, loose connections or any other obvious condition that might be a source of trouble.

5-120. SYMPTOMS.

5-121. Malfunctions in the Model 745A will normally produce one of the following major symptoms:

a. No Output (or output less than 50% of rated output)

b. Output Error (or poor load regulation or instability)

c. Poor Line Regulation

d. Output Distortion

e. Incorrect Output Frequency

f. Oscillations

5-122. Determine which of these major symptoms is the most applicable and refer to one of the following troubleshooting trees or paragraphs:

a. No Output Troubleshooting Tree (Figure 5-25)

b. Output Error Troubleshooting Tree (Figure 5-26)

c. Poor Line Regulation (Paragraph 5-144)

d. Output Distortion (Paragraph 5-146)

e. Frequency Scale Tracking (Paragraph 5-80)

f. Oscillations (Paragraph 5-149)

5-123. Checks outlined in the No Output and Output Error troubleshooting trees will lead to the probable cause of trouble or to troubleshooting trees for one of the following major sections:

a. Reference Square Wave Generator (Troubleshooting Tree Figure 5-27)

b. AGC Circuits (A2/A3 Troubleshooting Tree Figure 5-28)

c. Preamplifier/Power Amplifier (A4/A5 Troubleshooting Tree Figure 5-29)

d. Oscillator (A12 Troubleshooting Tree Figure 5-

5-124. The troubleshooting tree for each major section help isolate the trouble to a stage or component within t section or to other related circuitry. Some of the che outlined in the troubleshooting trees include board moval, shorting across relays or breaking feedback loops performed as outlined, these checks will simplify troubleshooting and eliminate many erroneous indications. E check should be performed carefully to avoid additio circuit failure. The "Probable Cause" information in troubleshooting trees only indicates the most likely fail areas; and designated components are not necessarily exact cause of trouble. The "Probable Cause" informat should be used in conjunction with voltages and wavefo on the schematic diagrams to further pinpoint the trou source.

5-125. BASIC CHECKS.

5-126. The following basic checks can be used to isol troubles to one of the major sections listed in Paragra 5-123).

NOTE

The following basic checks will only isolate troubles that appear on all voltage ranges or on the 1 V, 10 V *and* 100 V ranges. Troubles that appear on a single voltage range or group of related voltage ranges are normally caused by relay failures on the A6 or A7 Switching Assembly.

5-127. Check No. 1.

5-128. This check bypasses the AGC circuitry (A2/A3) the Reference Square Wave Generator (A1). A cor indication means that the Oscillator, Preamplifier Power Amplifier are operating properly. If desired, -1 V from an external source can be applied to XA2 pin 20 (removed) instead of shorting the AGC line (A2TP4) circuit ground. With -1 Vdc applied to XA2 pin 20, 745A output should be within ± 2% of the value set by

first two voltage-set controls. Regardless of the AGC bypassing method, if the indication is incorrect the trouble can be further isolated to the Oscillator or Preamplifier/Power Amplifier sections using Check No. 2.

a. Set 745A to 1.000000 V, 1 V range.

b. Short A2TP4 to circuit ground.

c. Monitor OUTPUT for clean sine wave (distortion < -68 dB) 0.75 V rms to 0.95 V rms all FREQUENCY RANGES and FREQUENCY dial settings.

5-129. Check No. 2.

5-130. This check is identical to Check No. 1 except for the monitoring point. In this check, the AGC circuits are bypassed and the signal at the COUNTER OUTPUT connector is monitored to determine if the Oscillator is operating properly. If the indication is correct, the trouble is in the Preamplifier, Power Amplifier or associated circuitry. If the indication is incorrect, the trouble is in the Oscillator.

a. Short A2TP4 to circuit ground.

b. Monitor COUNTER OUTPUT for clean sine wave (distortion < -66 dB) 1.6 V rms to 2.0 V rms all FREQUENCY RANGES and FREQUENCY dial settings.

5-131. Check No. 3.

5-132. If the Oscillator, Preamplifier and Power Amplifier are operating properly, the trouble is in the Reference Square Wave Generator (or associated circuitry) or in the AGC circuits. In this check, isolation is accomplished by monitoring the output of the Reference Divider (P/O A10) at any point on the sixth divider transformer (A10T6). The output of the Reference Divider should be a clean, symmetrical, 500 Hz square wave which can be varied in amplitude from 0.1 V rms (0.2 V p-p) to 1.1 V rms (2.2 V p-p). If the trouble is not related to specific decade settings and the -9.9 V and +9.9 V reference voltages are properly adjusted, monitoring the Reference Divider output with an oscilloscope is usually sufficient to verify correct operation of the Reference Square Wave Generator and Reference Divider. If further verification is required, the output of the Reference Divider can be measured at XA3 pin 13 using a *true rms responding* ac voltmeter such as the -hp- Model 3450A Multi-Function Meter. Note that the output of the Reference Divider will be approximately 0.01% higher than is indicated by the decade setting. This is due to shaping capacitor C2* which is factory selected to compensate for varying parameters in the AGC circuitry. If the output of the Reference Divider is incorrect, the trouble is in the Reference Square Wave Generator (A1), the 9:1 divider transformer (T1) or the Reference Divider. If the output of the Reference Divider is correct, the trouble is in A2, A3 or associated circuitry.

5-133. POWER SUPPLIES.

5-134. The 745A contains six major power supplies which provide regulated voltage for the various assemblies throughout the instrument. In addition, the instrument contains -9.9 V and +9.9 V regulators which provide voltage for the 19.8 V p-p reference square wave. Table 5-11 lists the noise and ripple, line regulation, nominal load current and other useful information pertaining to each power supply.

Table 5-11. Power Supply Data

POWER SUPPLY	TEST POINT	ADJUSTMENT	RIPPLE* (p-p)	LINE REGULATION (115 V/230 V ± 10%)	NOMINAL LOAD CURRENT*	NOMINAL CURRENT LIMIT
- 15 V	A1A1TP2	none (- 15 V ± 0.05 Vdc)	<8 mV	± 0.025 mV	150 mA	350 mA
+ 15 V	A1A1TP1	none (+ 15 V ± 0.05 Vdc)	<8 mV	± 0.05 mV	200 mA	350 mA
- 9.9 V	A1A3TP5	⑤ and ⑧	<5 mV	± 5 μV	DNA	DNA
+ 9.9 V	A1A3TP5	③ and ④	<5 mV	± 20 μV	DNA	DNA
- 25 V	A8TP1	⑳	<5 mV	± 0.5 mV	650 mA	0.95 A
+ 5.2 V/+ 5.8 V	A8TP2	⑩	<5 mV	± 0.5 mV	1350 mA	3 A
- 70 V	A8TP3	㉒	<10 mV	± 0.3 V	70 mA	350 mA
+ 70 V	A8TP4	㉑	<10 mV	± 0.3 V	60 mA	350 mA

*745A set to 1.000000 mV, 1 kHz.

5-135. Before attempting to troubleshoot any power supply, be sure the apparent power supply failure is not caused by an overload. This can be accomplished by removing appropriate printed-circuit boards and rechecking the power supply voltage. Table 5-12 is a truth table which lists the various power supply voltages and indicates the printed-circuit boards on which they are used.

5-136. 15 Volt Power Supplies (A1A1 Schematic No. 1)

5-137. The -15 V and +15 V regulators obtain raw voltages from the Primary Power Supply Assembly (A9). Each circuit consists of a series regulator, a current limit detector and two differential control amplifier stages. The first control amplifier for the -15 V supply is located on the Reference Regulator board in the Oven Assembly. This control amplifier is referenced to -6 Vdc provided by A1A2A1CR1. The voltage applied to A1A2A1CR1 is, in turn, furnished by the -15 V supply. The first control amplifier in the +15 V regulator circuit is referenced to -15 V. The +15 V supply furnishes collector voltage for the second control amplifier stage in the -15 V regulator circuit.

5-138. The 15 volt supplies are difficult to troubleshoot since a failure in either of the regulator circuits or in the -6 Vdc reference supply can affect both supply voltages and the reference. The bias levels in these regulator circuits are relatively critical and "short cut" troubleshooting methods are not recommended. With few exceptions, the fastest way to troubleshoot these circuits is to chec suspected components with an ohmmeter or transisto tester.

Table 5-12. Voltage Distribution

ASSEMBLY	- 15 V	+ 15 V	- 25 V	+ 5.2V	+ 5.8V	- 70 V	+ 70 V
A1A3	X	X					
A1A4	X	X	X				
A2	X	X		X			
A3	X	X	X	X			
A4	X	X	X			X	
A5	X	X	X			X	X
A6				X			
A7				X			
A11				X			
A12A1	X	X			X		
A12A2		X			X		
A12A3		X			X		
A12A4		X			X		
A12A5	X	X					
A12A6	X	X	X				
A12A7		X	X				
A12A8		X	X				
A13					X		

CAUTION

COMPONENTS ON THE REFERENCE REGULATOR ASSEMBLY (A1A2A1) ARE NOT SEPARATELY REPLACEABLE IN THE FIELD. IF ONE OF THESE COMPONENTS SHOULD FAIL, CONTACT THE NEAREST -hp- SALES AND SERVICE OFFICE OR CUSTOMER SERVICE FACILITY FOR FURTHER ASSISTANCE.

5-139. 9.9 Volt Regulators (A1A3 Schematic No. 3).

5-140. The -9.9 V and +9.9 V regulators obtain pr regulated voltage from the 15 volt supplies. For this reaso the 15 V supplies should be checked before troubleshootin any portion of the 9.9 V regulator circuits. The 9.9 regulators each consist of a series regulator and two contr amplifier stages. The outputs of the regulators are applie to switching circuits which are gated alternately by 500 Hz square wave from A1A4. During calibration, th -9.9 Vdc and +9.9 Vdc reference voltages can be adjuste using the procedure outlined in Paragraph 5-62. Since the voltages are used to produce the 19.8 V p-p referen square wave, a failure in either the -9.9 V or +9.9 regulator or switching circuits can affect the basic accurac of the instrument. In order for these voltages to produce significant error at the OUTPUT terminals, however, the must deviate considerably from the ± 10 μVdc toleranc listed in the adjustment procedure. For example, if eith of the 9.9 volt references is out of tolerance b ± 1.8 mVdc, the rms error introduced at the OUTPU terminals will be ± 0.01% of setting.

5-141. In terms of stability, the most critical areas in th 9.9 V regulator circuits are the first control amplifier stage These differential amplifiers are located on the Referen Regulator board (A1A2A1) in the Oven Assembly. The fir control amplifier in the -9.9 V regulator circuit is refe enced to -6 Vdc provided by A1A2A1CR1. The -6 V reference can be measured at XA1 pin 12 and should b -6 V ± 5 mVdc after a 1 hour warmup with the A1 to cover in place. The first control amplifier in the +9.9 regulator circuit is referenced to the output of the err measurement network (P/O A1A4). Checks outlined in th adjustment procedure (Paragraph 5-62) will normally reve a malfunction in the error measurement network. frequent adjustment of the -9.9 V or +9.9 V reference required, the most likely cause of trouble is the first contr amplifier stage or the -6 Vdc reference.

5-142. 70 Volt Supplies (A8 Schematic No. 11).

5-143. The 70 volt supplies furnish −70 Vdc and + 70 Vdc (regulated) to the Preamplifier (A4) and Power Amplifier (A5). Due to the 70 volt interlocks between A4 and A5, these voltages are applied to A5 only when A4 is installed. Nearly any failure in the power amplifier section will cause either or both 70 V supplies to current limit. Before troubleshooting the 70 V supplies, remove A5 and recheck the supply voltages to determine if the trouble is in the supply or in the load. Checks outlined in the A4/A5 Troubleshooting Tree (Figure 5-29) are designed to remove the overload from the 70 V supplies to permit A5 troubleshooting. The load capability of of the 70 V supplies can be checked by removing the Preamplifier (A4) and connecting a resistive load (250 ohms to 700 ohms) to A8TP3 (−70 Vdc) or A8TP4 (+ 70 Vdc).

5-144. POOR LINE REGULATION.

5-145. Poor line regulation can be caused by a failure in any of the regulated power supplies. The most frequent causes of trouble are the 15 volt supplies since they affect the −9.9 V and + 9.9 V references which, in turn, establish the basic accuracy of the instrument. The line regulation of each power supply can be checked using the data listed in Table 5-11.

5-146. OUTPUT DISTORTION.

5-147. Due to the exceptionally low distortion levels at the output of the Model 745A, distortion readings can be severely affected by undesirable ground currents or by distortion and noise introduced by the measuring equipment. Before troubleshooting the 745A, perform the following:

a. Minimize ground currents by isolating either the 745A or the measuring equipment from power line ground.

b. Check the performance of the distortion analyzer. This is particularly important if the 745A output distortion is within specifications at midband frequency settings but appears marginal or out of tolerance at frequencies below 50 Hz and/or above 50 kHz.

c. Monitor the output of the distortion analyzer using an oscilloscope. This will reveal the nature of the distortion.

5-148. To isolate the trouble within the 745A, proceed as follows:

a. Perform the Power Supply and Bias Adjustments (Paragraph 5-44) and the Oscillator Adjustments (Paragraph 5-64).

b. Monitor each regulated supply voltage using an oscilloscope. Ripple and noise figures are listed in Table 5-11.

c. Isolate the trouble to a major section by performing the first two Basic Checks outlined in Paragraphs 5-127 and 5-129. Refer to the troubleshooting tree for the major section that is causing the distortion.

5-149. OSCILLATIONS.

5-150. Oscillations that appear at the output of the 745A are normally the direct result of parasitic or loop oscillations in the Preamplifier (A4) and/or Power Amplifier (A5). In many cases, oscillations appear intermittently and are initiated by changing frequency ranges. Unless the oscillations are sustained and produce a definite symptom such as output error or no output (output < 50%), systematic troubleshooting is difficult. It is important, however, to check for the dc voltages shown on the schematics. The following is a list of typical causes of oscillations:

NOTE

If oscillations are sustained and produce a definite symptom such as output error or no output, refer to the Output Error Troubleshooting Tree (Figure 5-26) or the No Output Troubleshooting Tree (Figure 5-25).

a. Incorrect biasing (A4/A5). Check dc voltages shown on schematics.

b. Incorrect bias at A12A8TP2 or A12A8C16 leaky.

c. A4C8 leaky or shorted.

d. Resistive or shorted relays in the high or low frequency output network (P/O A4).

e. Shaping or bypass capacitors on A4 or A5 (primarily electrolytics).

f. Leakage between A5 transistor mounting bracket (circuit ground) and collector of A5Q1, A5Q2, A5Q9 or A5Q10.

g. A4Q1

h. Leakage between collector of Q6 (on the mainframe) and circuit ground.

i. Dynamic failure of transistors or Zener diodes on A4 or A5.

5-151. REED RELAYS.

5-152. Reed relays are used for various switching functions throughout the instrument. These relays can become open, shorted, resistive, leaky or intermittent. If a relay is suspected of being open, resistive or intermittent, the simplest check is to select the range or function that normally energizes the relay and short across the relay contacts. If the symptom disappears, the trouble is in the relay or associated driver circuitry. Relays on A2, A3, A4, A6 and A7 can be checked for shorts or leakage (in circuit) by removing the printed circuit board and measuring the resistance across relay contacts. The resistance should be greater than 100 Megohms. Sense relays A13K1 and A13K2 can be checked for leakage by measuring the resistance between LO OUTPUT and LO SENSE and between HI OUTPUT and HI SENSE (with the instrument turned off). Relays A1A4K1 and A1A4K2 in the error measurement network can be checked by disconnecting one end of A1A4R30 and A1A4R32 and measuring the leakage resistance across the relay contacts.

5-153. Troubles that appear on a single voltage range or group of related voltage ranges are normally caused by relay failures on the A6 and A7 Switching Assemblies. The Functional Block Diagram (Figure 7-1) can be used to determine which relays are energized when particular voltage ranges are selected.

* Note from page A-20.

_____ NOTE _____

"The overload light illuminates when the reference voltage switch is moved to the + or -9.9 volt position. The light will extinguish when the switch is returned to the 19.8v position."

5-154. AC FEEDBACK ADJUSTMENTS.

5-155. The purpose of the following adjustments is to s the inside loop feedback in the -9.9 V and +9.9 regulator circuits. These adjustments have negligible affe on the output voltage accuracy and should be performe *only if* A1A2A1 or A1A3 has been repaired or replace These adjustments are performed at the factory to provi optimum reference square wave accuracy and should n require further attention.

a. Perform the Reference Square Wave Voltage A justment procedure (Paragraph 5-62).

b. Set A1A4S1 to the -9.9 V position.

c. Connect the dc differential voltmeter t A1A3TP4. Record reading:____V. (Reading wi be approximately -9.92 V.)

d. Set A1A4S1 to the +9.9 V position. Adju A1A3R26 (2) until voltage at A1A3TP4 is 40 m lower than the value recorded in Step c.

e. Connect the dc differential voltmeter t A1A3TP3. Record reading:____V. (Reading wi be approximately +9.92 V).

f. Set A1A4S1 to the -9.9 V position. Adju A1A3R9 (1) until voltage at A1A3TP3 is 40 m lower than the value recorded in Step e.

g. Repeat the Reference Square Wave Voltage Ad justment procedure (Paragraph 5-62).

5–155. Calibration

5–156. Test Instrument Identification

Paragraphs 5–156 through 5–166 provide instructions for the calibration of Ac Calibrator, Hewlett-Packard Model 745A–C90 which will be referred to as the "test instrument" throughout these paragraphs. The time required for this calibration is approximately 8 hours, using the dc and low frequency technique.

5–157. Calibration Data Card (DA Form 2416)

Maintenance forms, records, and reports which are to be used by calibration personnel at all calibration levels are listed in and prescribed by TM 38–750.

5–158. Calibration Description

Test instrument parameters and performance specifications which pertain to this calibration are listed in table 1–1.

5–159. Equipment Required

Table 5–13 identifies the specific equipment used in this calibration procedure. This equipment is issued with secondary reference calibration standards set 4931–621–7878 and is to be used in performing this procedure. Alternate items may be used by the calibrating activity when the equipment listed in table 5–13 is not available. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 5–13. The accuracies listed in table 5–13 provide a four-to-one accuracy ratio between the standard and test instrument. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

Table 5–13. Minimum Specifications of Equipment Required

Item	Common Name	Minimum Use Specifications	Manufacturer, Model, and Part No.
A1	AC/DC VOLTMETER	Range: −70.5 to +70.5 vdc Capability: Use as a null detector	John Fluke, Model 887AB (MIS–10216)
A2	AMPLIFIER	Range: 10 mv to 1 v input Capability: 10 db gain between steps	Ballantine, Model 310A (8616133–4)[1]
A3	AUTOTRANSFORMER	Range: 105 to 125 vac Accuracy: ±1%	General Radio, Model W10MT3AS3 (7910809)
A4	DECADE RESISTOR	Range: 22.1 to 3010 ohms	Biddle-Gray, Model 601147–1 (7910328)
A5	DC VOLTAGE STANDARD	Range: .99965 to 100.032 vdc Accuracy: ±0.0085%	John Fluke, Model 332A (7911393)
A6	DISTORTION ANALYZER	Range: 10 Hz to 100 kHz at 1 v Capability: Measure less than .06%	Hewlett Packard, Model 334A (7911957)
A7	FREQUENCY COUNTER	Range: 9.8 Hz to 102 kHz Accuracy: ±2% of setting	Systron-Donner, Model 1037M2 (7910628)
A8	OSCILLOSCOPE	Sensitivity: 0.01 to 10 v/cm Sweep Time: 2 msec to 10 msec/cm	Teletronix, Model RM561A (7910655)
A9	RATIO TRANSFORMER	Capability: Divide to seven places Accuracy: ±0.0085%	Gertch, Model 1000 (7907061–1)
A10	THERMAL TRANSFER STANDARD	Range: .99965 to 100.032 vac Accuracy: ±0.0085% (+0.01)	Holt, Model 10 (7911000–1)

[1] Transfer item.

5–160

The accessories listed in table 5–14 are issued with secondary reference calibration standards set 4931–621–7878 and are to be used in this calibration procedure. When necessary, these items may be substituted by equivalent items unless specifically prohibited.

5–161. Preliminary Instructions

a. The instructions outlined in this section are

preparatory to the calibration process. Personnel should become familiar with the entire procedure before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 5–13 and 5–14. For the identification of equipment referenced by item numbers prefixed with A, see table 5–13, and for prefix B, see table 5–14.

c. Connect test instrument to autotransform (A3).

d. Connect autotransformer to 115-vac sour and adjust for 115-volt output.

e. Set test instrument LINE switch to ON a allow 1 hour for equipment to warm up a stabilize.

Table 5–14. Accessories

Item No.	Common Name	Description and Part No.
B1	CABLE	30-in., RG–58()/U; with BNC plug terminations (7907467)
B2	CABLE	36-in., RG–58()/U; with BNC plug to alligator clips (7908410)
B3	CABLE[1]	36-in., RG–58()/U; with double banana plug terminations (7907470)
B4	PROBE	Tekronix, Type 6006
B5	CABLE	36-in., RG–58()/U; with BNC plug and double banana plug termination (7907471)
B6	HOOK-UP WIRE	Shielded pair No. 18 AWG, 100 v solid copper (MIS–16812)
B7	ADAPTER	3 to 2 wire isolation plug (7912856)
B8	ADAPTER	Double banana plug to BNC plug (7909400)

[1] Four required.

5–162. Frequency Accuracy

a. Performance check.

(1) Connect test instrument COUNTER OUTPUT (rear panel) to frequency counter (A7) using cable (B1).

(2) Position test instrument controls as follows:

(*a*) FREQUENCY RANGE to X10.

(*b*) FREQUENCY control for FREQ sca indication of 1.

(*c*) VOLTAGE RANGE to 1V.

(*d*) Voltage controls to 1.000000 V.

(3) Frequency counter will indicate betwee 98.0392 and 102.041 ms. If not, perform *b* belo

(4) Repeat technique of (2) and (3) abov using settings and indications listed in table 5–1

Table 5–15. Frequency Accuracy

Test Instrument		Frequency Counter Indication	
Frequency Setting	Frequency Range	Min	Max
2	X10	49.0196 ms	51.0204 ms
3		32.6797 ms	34.0136 ms
5		19.6078 ms	20.4082 ms
7		14.0056 ms	14.5778 ms
10		9.8039 ms	10.2041 ms
1	X100	9.80392 ms	10.2041 ms
2		4.90196 ms	5.10204 ms
3		3.26797 ms	3.40136 ms
5		1.96078 ms	2.04082 ms
7		1.40056 ms	1.45778 ms
10		980 Hz	1020 Hz
1	X1K	980 Hz	1020 Hz
2		1960 Hz	2040 Hz
3		2940 Hz	3060 Hz
5		4900 Hz	5100 Hz

Table 5–15. Frequency Accuracy—Continued

Test Instrument		Frequency Counter Indication	
		Min	Max
1		[illegible]	[illegible]
2		[illegible]	[illegible]
1		[illegible]	[illegible]
2		[illegible]	[illegible]
3		[illegible]	[illegible]
5	X10K	[illegible]	[illegible]
7		[illegible]	[illegible]
10		[illegible]	[illegible]

b. Adjustments.

(1) Set test instrument FREQUENCY RANGE to X10K and FREQUENCY control for FREQ scale indication of 1.0 Hz.

(2) Adjust A12C2 (10 kHz ADJ) (fig. 7–2) for an indication of 10.000 kHz on frequency counter.

(3) Rotate the FREQUENCY control slowly clockwise while observing frequency counter indication. If frequency increases, proceed to step *b* (6) below. If frequency decreases, proceed to step *b* (4) below.

(4) Repeat (1) above.

(5) While observing the frequency counter indication, adjust A12C2 (fig. 7–2) until a second 10 kHz output frequency is obtained. If a second 10 kHz cannot be reached by adjusting A12C2 (fig. 7–2), readjust A12C2 for the original 10-kHz frequency. While observing the frequency counter indication, adjust A12L1 (fig. 7–2) in the direction that causes the output to decrease and pass through 0 (zero) Hz and increase to 10 kHz. Adjust A12L1 (fig. 7–2) for an indication of 10.000 kHz on the frequency counter.

(6) Adjust the test instrument FREQUENCY control for a FREQ scale indication of 10.0. Record frequency counter indication.

(7) Refer to table 5–16 frequency counter indication column and locate the frequency nearest to the one recorded in (6) above. Record the corresponding frequency in the adjoining column.

(8) Adjust A12L1 (100 kHz ADJ) (fig. 7–2) for the frequency recorded in (7) above.

(9) Rotate the FREQUENCY control counterclockwise for a FREQ scale indication of 10 kHz while observing the frequency counter to insure the indication does not pass through 0 (zero) Hz. If the output frequency passes through 0 (zero) Hz, repeat (2) through (8) above.

(10) Adjust test instrument FREQUENCY control for a scale indication of 1.0. Adjust A12C2 for an indication of 10.00 kHz on the frequency counter.

(11) Repeat (6) through (10) above until frequency counter indications are within tolerance at frequency settings of 10 and 100 kHz.

(12) Repeat *a* (2) through (4) above and if

Table 5–16. FREQUENCY Scale Tracking

Frequency Counter Indication (kHz)	Set A12L1 to Obtain (kHz)
80	150
81	147
82	144
83	142
84	139
85	137
86	134
87	131
88	129
89	126
90	124
91	121
92	119
93	117
94	114
95	112
96	109
97	107
98	104.6
99	102.3
100	100
101	97.69
102	95.41
103	93.2
104	90.9
105	88.7
106	86.4
107	84.1
108	82.1
109	79.9
110	77.8
111	75.6
112	73.5
113	71.4
114	69.3
115	67.2
116	65.1
117	63.1
118	61.0
119	59.0

lower frequency ranges (X10 through X1K) are still out of tolerance, perform the following steps:

(*a*) Extend circuit board A12A2 (fig. 7–2) using extender board furnished with test instrument.

(*b*) Connect oscilloscope (A8) to A12A2-TP1 (fig. 5–33) using probe (B4).

(*c*) Adjust A12A2T1 (fig. 5–33) for maximum amplitude of the ac signal displayed on oscilloscope (fig. 5–11).

(*d*) Set test instrument FREQUENCY RANGE to X10K and FREQUENCY control for FREQ scale indication of 1.0.

(*e*) Connect oscilloscope to A12A2TP2 (fig. 5–33 and 7–19) using probe (B4).

(*f*) Adjust A12A2C11 and A12A2C18 (fig. 5–33 and 7–19) for maximum amplitude of the ac signal displayed on oscilloscope.

(*g*) Set test instrument FREQUENCY control for FREQ scale indication of 11.0.

(*h*) Adjust A12A2C14 (fig. 5–33 and 7–19) for maximum signal amplitude.

(*i*) Set test instrument FREQUENCY control for FREQ scale indication of 1.0.

(*j*) Adjust A12A2C11 (fig. 5–33 and 7–19) for maximum signal amplitude.

(*k*) Vary test instrument FREQUENCY control for FREQ scale indications from 1.0 to 11.0. Signal amplitude will be approximately the same at both ends. Adjust A12A2C18 (fig. 5–33) to insure both ends are the same amplitude.

(*l*) Repeat (*f*) through (*k*) above as necessary to obtain optimum adjustments. Signal at A12A2TP2 (fig. 5–33) will be 0.7 v p–p or greater at frequencies from 10 to 110 kHz.

(*m*) Replace A12A2 in the test instrume and extend A12A3 (fig. 7–2) with extender boar

(*n*) Connect oscilloscope to A12A3T (fig. 5–33) using probe (B4).

(*o*) Adjust A12A3T1 (fig. 5–33 and 7–1 for maximum signal amplitude as indicated on c cilloscope.

(*p*) Set test instrument FREQUENC control for FREQ scale indication of 5.5.

(*q*) Connect oscilloscope to A12A3TP using probe (B4).

(*r*) Adjust A12A3C11 (fig. 5–33), A12 3C14, and A12A3C18 (fig. 5–33) for maximu signal amplitude as indicated on oscilloscope.

(*s*) Replace A12A3 in test instrument a extend A12A4 (fig. 7–2) with extender board.

(*t*) Repeat technique of (*n*) through (above for A12A4. Replace A12A4 in test instr ment.

(13) Repeat *a* (1) through (4) above.

5–163. Error Measurement

a. Performance Check.

(1) Insert adapter (B7) between test instr ment and autotransformer and connect test i strument OUTPUT and SENSE terminals to r tio transformer (A9) using hook-up wire (B6 Monitor output of ratio transformer using ac/d voltmeter (A1) using hook-up wire (B6).

(2) Position test instrument controls as fo lows:

Table 5–17. Error Measurement

Test Instrument		Ratio Transformer Setting	Ac/Dc Voltmeter Indication
ERROR RANGE Setting	% ERROR Scale Setting		
X1	−3	.970874	Value of 3 above ±0.00015 v
X1	−2	.980392	Value of 3 above ±0.00015 v
X1	−1	.990099	Value of 3 above ±0.00015 v
X1	0	1.000000	Value of 3 above ±0.00015 v
X1	+3	1.030929	Value of 3 above ±0.00015 v
X1	+2	1.020408	Value of 3 above ±0.00015 v
X1	+1	1.010101	Value of 3 above ±0.00015 v
X.1	0	1.000000	Value of 3 above ±0.000015 v
X.1	−3	.997009	Value of 3 above ±0.000015 v
X.1	+3	1.003009	Value of 3 above ±0.000015 v

(*a*) VOLTAGE RANGE to 1V.
(*b*) Voltage set controls to 1.000000 V.
(*c*) FREQUENCY control for FREQ scale indication of 1.
(*d*) FREQUENCY RANGE to X1K.
(*e*) ERROR RANGE to 0.
(*f*) SENSE to REMOTE.

(3) Set ratio transformer dials to 1.000000 and record the ac/dc voltmeter indication.

(4) Set test instrument ERROR RANGE to X1 and set the ERROR MEASUREMENT control for an indication of 0 (zero) on the % ERROR scale. Ac/dc voltmeter will indicate value recorded in (3) above ±0.00015 v. If not, perform *b* below.

(5) Repeat technique of (3) and (4) above, using settings and indications listed in table 5–17.

b. Adjustments.

(1) Set A1A4S1 (fig. 7–2 and 7–3) to the +9.9 v position.

NOTE

Overload lamp illuminates.

(2) Connect the ac/dc voltmeter to A1A3TP5 (fig. 5–32) using probe (B4).

(3) Set ERROR RANGE to 0 and adjust ERROR MEASUREMENT control for an indication of 0 (zero) on the % ERROR scale. Record the ac/dc voltmeter indication.

(4) Set ERROR RANGE to X1. Loosen the two set screws that fasten the drive sprocket to the shaft of the error potentiometer (fig. 5–33).

(5) Using a pair of long-nosed pliers, rotate the shaft of the error potentiometer until the ac/dc voltmeter indicates the exact value recorded in (3) above.

(6) Holding the shaft of the error potentiometer in place, adjust the ERROR MEASUREMENT control for an exact 0 (zero) on the % ERROR scale.

(7) Repeat adjustments as necessary for optimum operation.

(8) Set A1A4S1 +9.9 v switch to center position.

5–164. Voltage accuracy and regulation

a. Performance check.

(1) Connect equipment as shown in figure 5–34, and adjust decade resistor (A4) for 22.1 ohms.

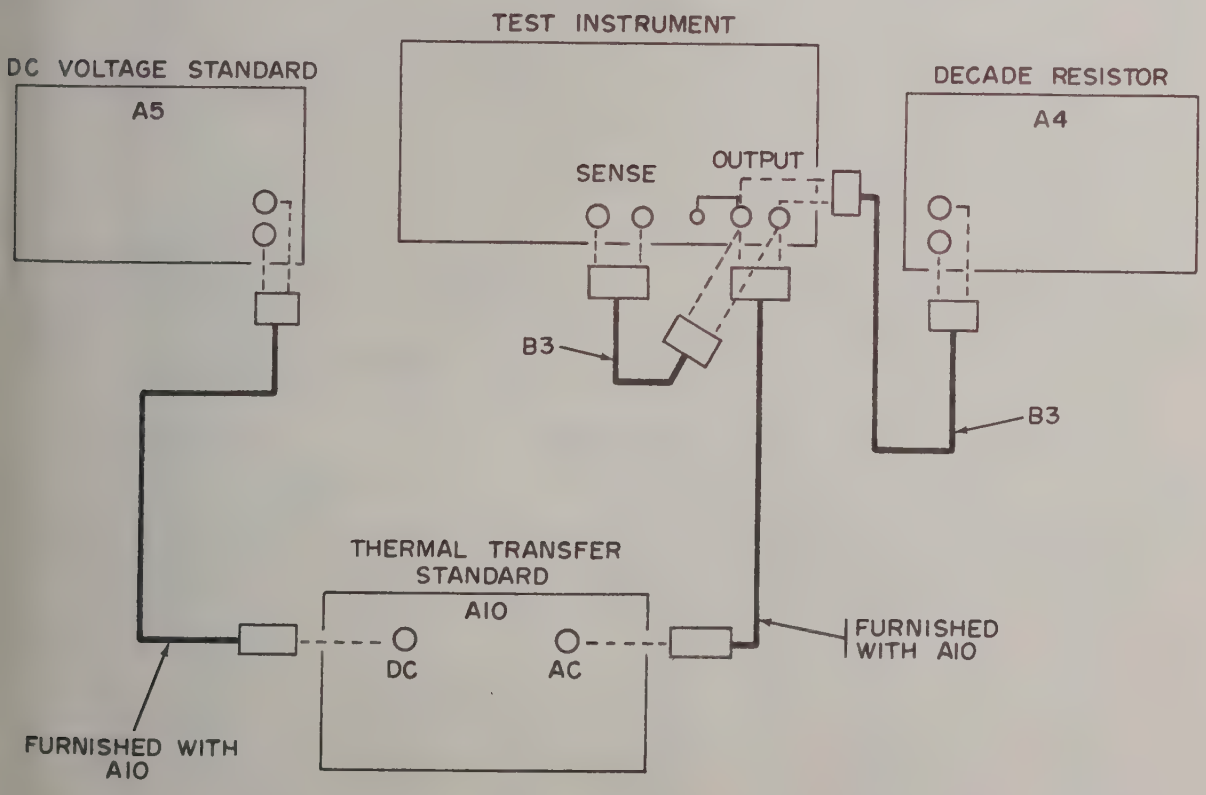


Figure 5–34. Output voltage—equipment setup.

(2) Position test instrument controls as follows:

(*a*) VOLTAGE RANGE to 1V.

(*b*) Voltage set controls to 1.000000V.

(*c*) FREQUENCY RANGE to X1K.

(*d*) FREQUENCY control for FREQ scale indication of 1.0.

(*e*) ERROR RANGE to 0.

(*f*) SENSE to REMOTE.

(3) Using standard ac/dc transfer technique measure the voltage out of the test instrument. Dc voltage standard (A5) will indicate between 0.99965 and 1.00035 v (record indication). If not, perform *b* below.

(4) Vary output of autotransformer (A3) output and between 105 and 125 volts. Test instrument output will remain within ±0.001% of indication recorded in (3) above.

(5) Repeat technique of (2) and (3) above, using settings and indications listed in table 5–18.

(6) Connect equipment as shown in figure 5–35.

(7) Set radio transformer (A9) to .0010 and decade resistor (A4) for 22.1 ohms.

(8) Repeat (2) above.

(9) Set ERROR RANGE to X.1 and ERROR MEASUREMENT control until % ROR scale indicates reading recorded in (above.

(10) Set the amplifier to the 10 mv RAN and null the ac/dc voltmeter (A1). After nulli do not reset ac/dc voltmeter.

(11) Set the test instrument VOLTA RANGE to 1 mV.

(12) Set the ratio transformer to 1.000000

(13) Set the decade resistor to 3010.00 ohn

(14) Set the test instrument voltage set co trols to obtain a null on the ac/dc voltmeter. instrument indication will be between .989600 a 1.010400 mV.

(15) Set decade resistor to 22.1 ohms.

(16) Set ratio transformer to .010000.

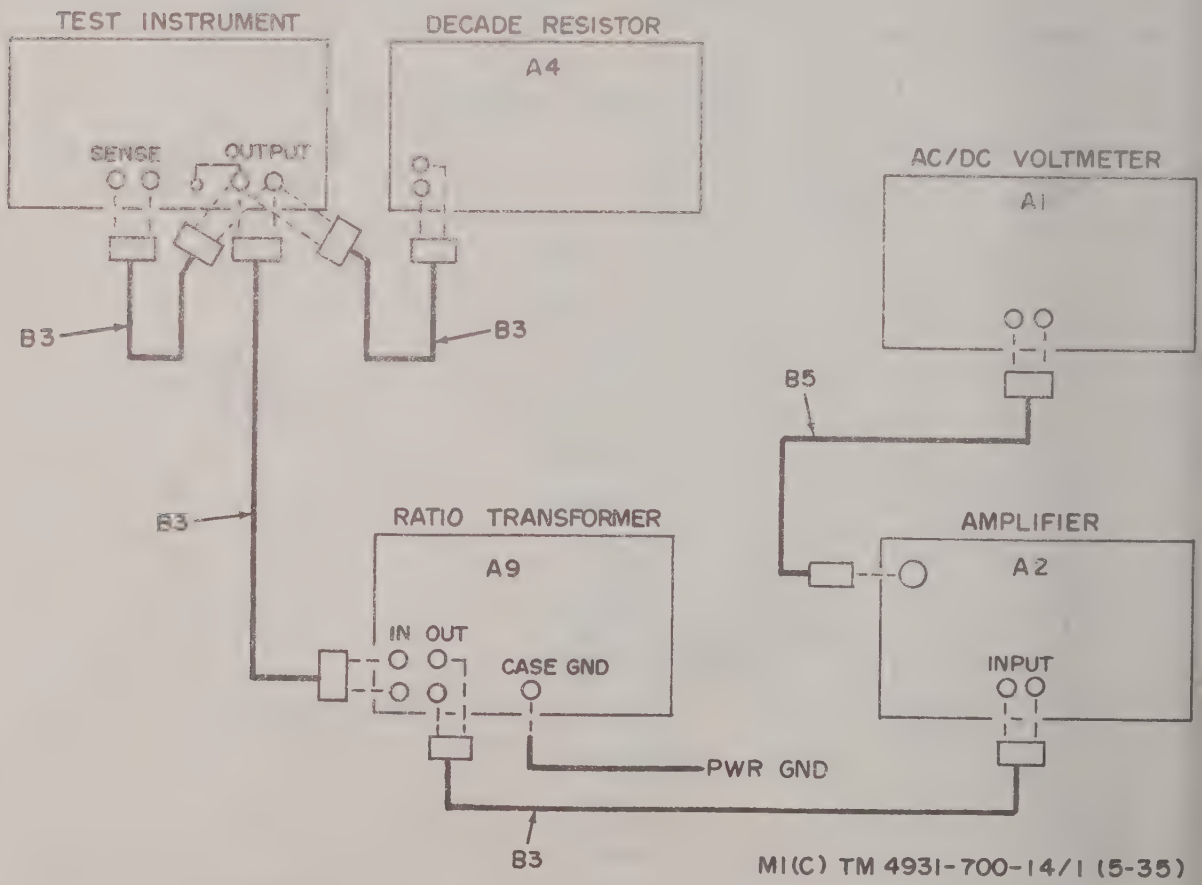


Figure 5–35. Low voltage output—equipment setup.

(17) Set test instrument voltage set controls to 1.000000 and VOLTAGE RANGE to 1V.

(18) Set amplifier (A2) to 100 mV RANGE.

(19) Set ac/dc voltmeter to obtain null. After nulling, do not reset ac/dc voltmeter.

(20) Set the VOLTAGE RANGE to 10 mV.

(21) Set the ratio transformer to 1.000000.

(22) Set the decade resistor to 3,010 ohms.

(23) Set the test instrument voltage set controls to obtain a null on the ac/dc voltmeter. Test instrument indication will be between 9.98580 and 10.01420.

(24) Repeat (15) above.

(25) Set ratio transformer to .100000.

(26) Repeat (17) above.

(27) Set amplifier to 1V RANGE.

(28) Repeat (19) above.

(29) Set the VOLTAGE RANGE to 100 mV.

(30) Repeat steps (21) and (22) above.

(31) Set the test instrument voltage set controls to obtain a null on the ac/dc voltmeter. Test instrument indication will be between 99.9480 and 100.0520.

b. Adjustments.

(1) Adjust the thermal transfer voltmeter (A10) and dc voltage standard to measure 1.000000 volt ac.

(2) Position test instrument controls as follows:

(*a*) VOLTAGE RANGE to 1V.

(*b*) Voltage set controls to 1.000000V.

(*c*) FREQUENCY RANGE to X10K.

(*d*) FREQUENCY control for FREQ scale indication of 10.

(3) Adjust A3C12 (fig. 5–32) for 1.000000 volt ac as indicated by thermal transfer voltmeter.

(4) Repeat (1) above for 10.00000 volts ac.

(5) Set test instrument VOLTAGE RANGE to 10V and voltage set controls to 10.00000 v.

(6) Adjust A6R16 (fig. 7–2) for 10.00000 volts ac as indicated by thermal transfer voltmeter.

(7) Repeat (1) above for 100.0000 volts ac.

(8) Set test instrument VOLTAGE RANGE to 100V, voltage set controls to 100.0000 v, FREQUENCY RANGE to X1K, and FREQUENCY control for FREQ scale indication of 1.

(9) Adjust A14R7 (fig. 7–2) for 100.0000 volts as indicated on thermal transfer voltmeter.

(10) Set test instrument FREQUENCY RANGE to X10K and FREQUENCY control for FREQ scale indication of 10.

(11) Adjust C9 (fig. 7–2) for 100.0000 volts as indicated on thermal transfer voltmeter.

5–165. Distortion

a. Performance check.

(1) Connect equipment as shown in figure 5–36.

(2) Position test instrument controls as listed below:

(*a*) VOLTAGE RANGE to 1V.

(*b*) Voltage set controls to 1.000000 V.

(*c*) FREQUENCY RANGE to X10.

(*d*) FREQUENCY control for FREQ scale indication of 1.0.

(*e*) ERROR RANGE to 0.

(*f*) SENSE to LOCAL.

(3) Adjust decade resistor (A4) for 22.1 ohms.

Table 5–18. Voltage Accuracy

Test Instrument		Dc Voltage Standard Indication (V)		Decade Resistor Setting (Ohms)
VOLTAGE RANGE Setting	Voltage Set Controls Setting	Min	Max	
10V	10.00000	9.99659	10.00341	221
10V	9.99999	9.99658	10.00340	221
10V	8.88888	8.88583	8.89193	221
10V	7.77777	7.77507	7.78047	221
10V	6.66666	6.66432	6.66900	221
10V	5.55555	5.54356	5.55754	221
10V	4.44444	4.44281	4.44607	221
10V	3.33333	3.33205	3.33461	221
10V	2.22222	2.22130	2.22314	221
10V	1.11111	1.11054	1.11168	221
100V	100.0000	99.9680	100.0320	2221

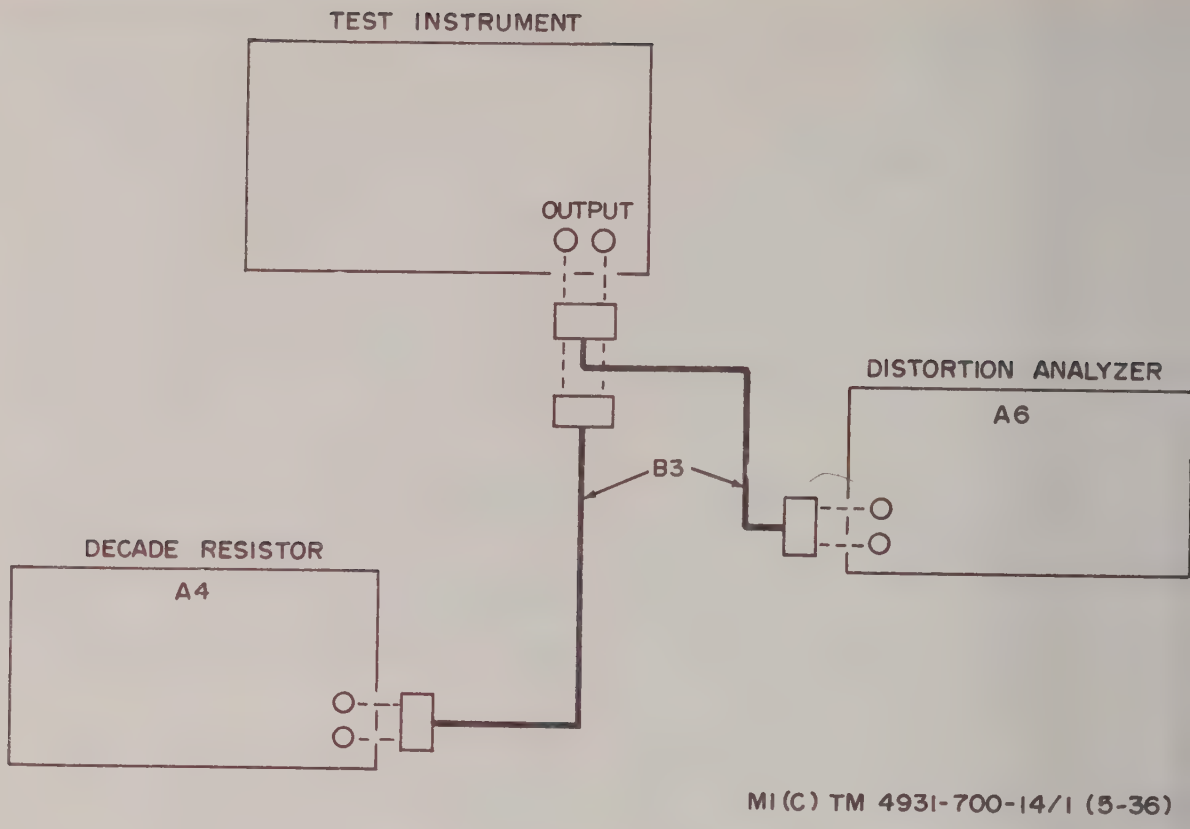


Figure 5–36. Distortion check—equipment setup.

(4) Measure distortion. Distortion will be .06% or less. If not perform *b* below.

(5) Repeat (4) above for frequencies of 50 Hz, 100 Hz, 1 kHz, 10 kHz, 50 kHz, and 100 kHz. Distortion will be .06% or less. If not, perform *b* below.

(6) Repeat technique of (2) through (5) above, using settings and indications listed in table 5–19.

b. Adjustments.

(1) Remove circuit board A12A5 (fig. 5–32) from test instrument and extend circuit board A12A7 (fig. 5–32), using extender board supplied with test instrument.

(2) Set test instrument FREQUENCY RANGE to X10K and FREQUENCY control for FREQ scale indication of 5.

(3) Connect oscilloscope (A8) to A12A7TP1 (fig. 5–33), using probe (B4) and connect ac/dc voltmeter (A1) to A12A8TP1 (fig. 5–33).

(4) Center potentiometers A12A7R26 and A12A7R29 (fig. 5–33).

(5) Adjust A12A7C14 (fig. 5–33) for minimum amplitude of the ac signal displayed on th oscilloscope.

(6) Alternately adjust A12A7R26 and A12A 7R29 (fig. 5–33) for minimum amplitude of th ac signal displayed on the oscilloscope.

(7) Repeat (5) and (6) above for optimu adjustment. The amplitude of the ac signa should be less than 0.05 v p–p.

(8) Slightly adjust A12A7R26 and A12A 7R29 for an indication of 0 ±2 mvdc.

(9) Repeat (5) through (8) above as neces sary to obtain an ac signal of 0.05 v p–p or les and a dc output of 0 ±2 mvdc.

(10) Replace circuit boards in test instru ment.

(11) Set test instrument FREQUENCY RANGE to X1K and FREQUENCY control fo FREQ scale indication of 1.

(12) Extend circuit board A12A8 (fig. 5–33) using extender board furnished with test instru ment.

(13) Connect ac/dc voltmeter to A12A8TP1 (fig. 5–33) and adjust A12A8R32 for an indica tion of 0.1 v rms.

(14) Connect ac/dc voltmeter A2TP4 (fig. 5–32) and adjust A12A6R4 (fig. 5–33) for an indication of −1 ±0.1 vdc.

(15) Connect ac/dc voltmeter to A12A8TP2 (fig. 5–33) and adjust A12A8R15 (fig. 5–33) for an indication of 0.3 ±0.05 vdc.

Table 5–19. Distortion

Test Instrument VOLTAGE RANGE	Maximum Distortion	Decade Resistor Setting
10V	.050%	221 ohms
100V	.050%	2000 ohms

5–166. Power Supply Check

NOTE

Do not perform power Supply check if all other parameters are within tolerance.

NOTE

In the following check procedures, all voltages are measured with respect to circuit common ( ). Circuit common is available at any point on the inner chassis.

a. Performance check.

(1) Set test instrument for output of 1.000000 mv at 1 kHz.

(2) Connect ac/dc voltmeter (A1) between A8TP3 (fig. 7–2 and 7–14) and circuit common, using cable and adapter (B2 and B8). Ac/dc voltmeter will indicate between −69.5 and −70.5 vdc. If not, perform *b* below.

(3) Repeat technique of (1) and (2) above for the settings and indications listed in table 5–20. If an out-of-tolerance condition is discovered, perform the corresponding adjustment.

b. Adjustments. Adjust A8R30 (fig. 7–2 and 7–14) for ac/dc voltmeter indication of −70.00 vdc.

Table 5–20. Power Supply and Bias

Test Instrument Connection Point	Connection Point Location (Fig.)	Ac/Dc Voltmeter, Frequency Counter or Oscilloscope Indication	Adjustments	Adjustment Location (Fig.)
A8TP4	fig. 7–2, 7–14	+69.50 to +70.50 vdc	A8R34	fig. 7–14
A8TP1	fig. 7–14	−24.80 to −25.20 vdc	A8R29	fig. 7–14
A8TP2	fig. 7–14	+5.10 to +5.30 vdc	A8R6	fig. 7–14
A4TP1	fig. 7–2, 7–10	−0.0030 to +0.0030 vdc	A4R8	fig. 7–10
A3TP1 [1]	fig. 7–2, 7–9	−0.0010 to +0.0010 vdc	A3R34	fig. 7–9
A2 pin 12 [2]	fig. 7–2, 7–8	450 to 550 ms sample gate	A3R10	fig. 7–9
A2TP1 [3]	fig. 7–2, 7–8	−0.0010 to +0.0010 vdc	A2R9	fig. 7–8
A2TP2 [4]	fig. 7–8	+0.550 to +0.650 vdc	A2R34	fig. 7–8
A2TP3	fig. 7–8	−0.0001 to +0.0001 vdc	A2R67	fig. 7–8
A2TP4 [5]	fig. 7–8	−0.90 to −1.10 vdc		
A2TP4 [6]	fig. 7–8	Indication equal to that recorded in footnote 5 below.	A4R39	fig. 7–10
A1A3TP5 [7]	fig. 7–2, 7–6	499 to 501 Hz	A1A4R5	fig. 7–7
A1A3TP5 [8]	fig. 7–6	−9.89999 to −9.9 0001 vdc	A1A3R32, R34	fig. 7–6
A1A3TP5 [9]	fig. 7–6	+9.89999 to +9.9 [10] 0001 vdc	A1A3R16, R14	fig. 7–6

[1] Set test instrument FREQUENCY RANGE to 50 kHz and A1A4S1 (fig. 7–2 and 7–8) to the +9.9 v position. Overload lamp may illuminate; this condition may be expected when A1A4S1 is switched from the 19.8 v position.

[2] Reset A1A4S1 to the 19.8 v position; connect oscilloscope (A8), using cable (B2).

[3] Remove PC board A8.

[4] Reinstall PC board A8; reset frequency to 50 kHz.

[5] Set test instrument FREQUENCY RANGE to 1 kHz; record indication.

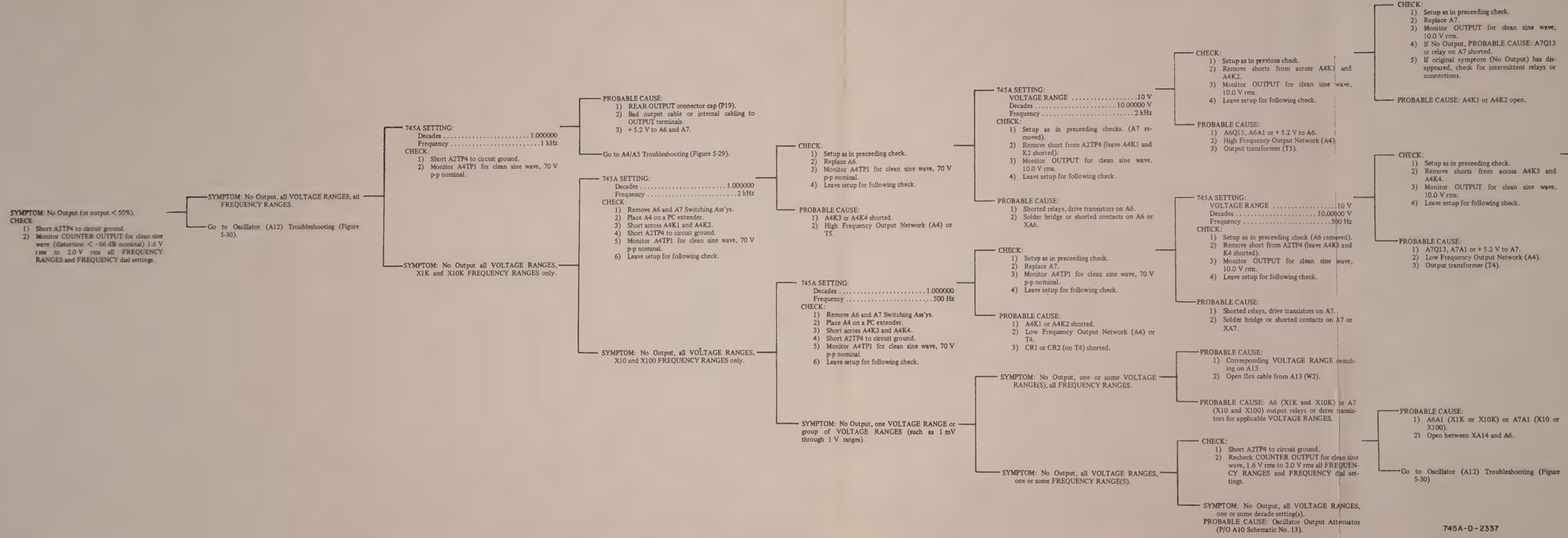
[6] Set test instrument FREQUENCY RANGE to X100.

[7] Connect frequency counter.

[8] Set A1A4S1 (fig. 7–2 and 7–8) to the −9.9 v position.

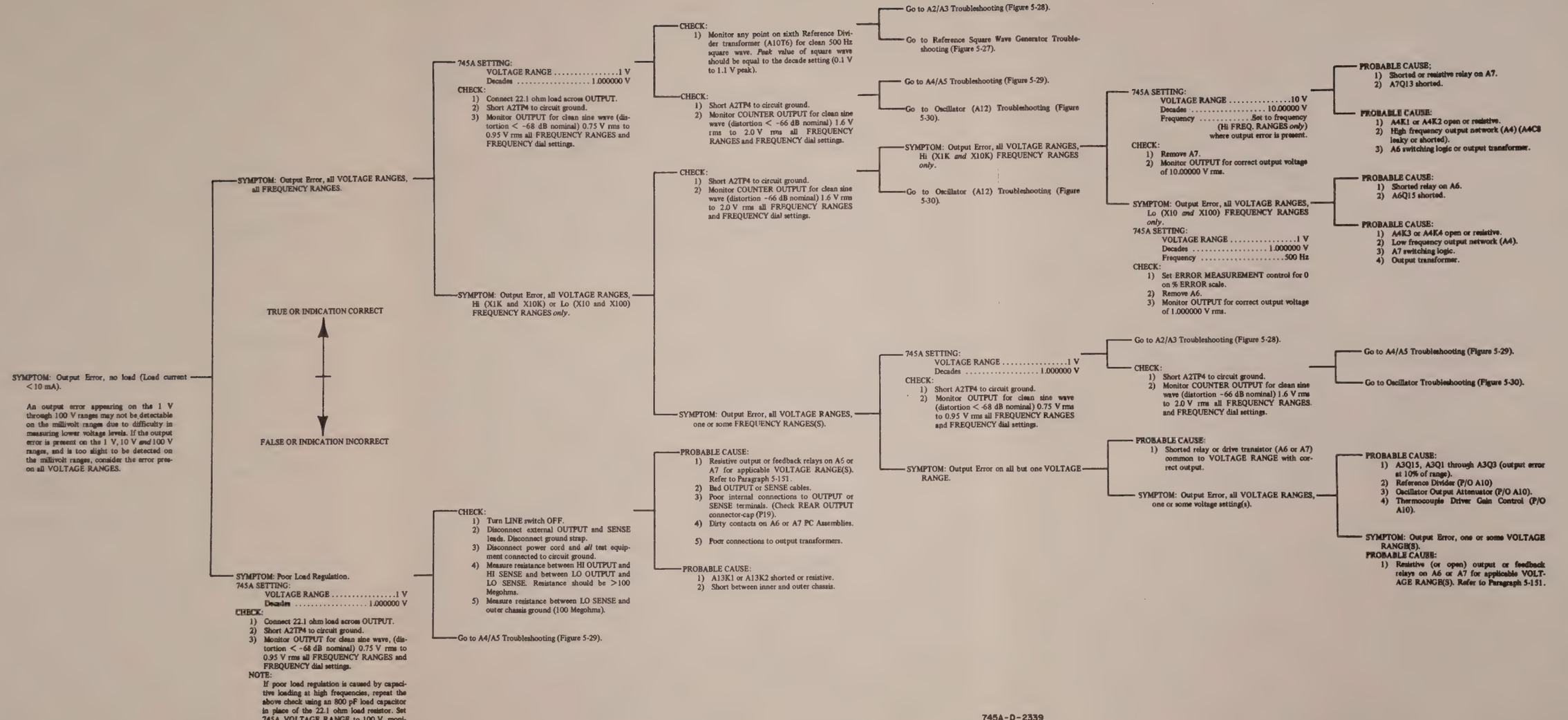
[9] Set A1A4S1 to the +9.9 v position.

[10] After completing the power supply check, set A1A4S1 to the 19.8 v position.


SYMPTOM: No Output (or output < 50%).
CHECK
1) Short A2TP4 to circuit ground.
2) Monitor COUNTER OUTPUT for clean sine wave (distortion < −66 dB nominal) 1.6 V rms to 2.0 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
SYMPTOM: No Output, all VOLTAGE RANGES, all FREQUENCY RANGES.
Go to Oscillator (A12) Troubleshooting (Figure 5-30).
745A SETTING:
Decades 1.000000
Frequency . . . . . 1 kHz
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor A4TP1 for clean sine wave, 70 V p-p nominal.
PROBABLE CAUSE:
1) REAR OUTPUT connector cap (P19).
2) Bad output cable or internal cabling to OUTPUT terminals.
3) + 5.2 V to A6 and A7.
Go to A4/A5 Troubleshooting (Figure 5-29).
SYMPTOM: No Output all VOLTAGE RANGES, X1K and X10K FREQUENCY RANGES only.
745A SETTING:
Decades 1.000000
Frequency . . . . . 2 kHz
CHECK:
1) Remove A6 and A7 Switching Ass'ys.
2) Place A4 on a PC extender.
3) Short across A4K1 and A4K2.
4) Short A2TP4 to circuit ground.
5) Monitor A4TP1 for clean sine wave, 70 V p-p nominal.
6) Leave setup for following check.
CHECK:
1) Setup as in preceeding check.
2) Replace A6.
3) Monitor A4TP1 for clean sine wave, 70 V p-p nominal.
4) Leave setup for following check.
PROBABLE CAUSE:
1) A4K3 or A4K4 shorted.
2) High Frequency Output Network (A4) or T5.
745A SETTING:
VOLTAGE RANGE . . . . . 10 V
Decades . . . . . 10.00000 V
Frequency . . . . . 2 kHz
CHECK:
1) Setup as in preceeding checks. (A7 removed).
2) Remove short from A2TP4 (leave A4K1 and K2 shorted).
3) Monitor OUTPUT for clean sine wave, 10.0 V rms.
4) Leave setup for following check.
PROBABLE CAUSE:
1) Shorted relays, drive transistors on A6.
2) Solder bridge or shorted contacts on A6 or XA6.
CHECK:
1) Setup as in previous check.
2) Remove shorts from across A4K1 and A4K2.
3) Monitor OUTPUT for clean sine wave, 10.0 V rms.
4) Leave setup for following check.
PROBABLE CAUSE:
1) A6Q15, A6A1 or + 5.2 V to A6.
2) High Frequency Output Network (A4).
3) Output transformer (T5).
CHECK:
1) Setup as in preceeding check.
2) Replace A7.
3) Monitor OUTPUT for clean sine wave, 10.0 V rms.
4) If No Output, PROBABLE CAUSE: A7Q13 or relay on A7 shorted.
5) If original symptom (No Output) has disappeared, check for intermittent relays or connections.
PROBABLE CAUSE: A4K1 or A4K2 open.
745A SETTING:
Decades 1.000000
Frequency . . . . . 500 Hz
CHECK:
1) Remove A6 and A7 Switching Ass'ys.
2) Place A4 on a PC extender.
3) Short across A4K3 and A4K4.
4) Short A2TP4 to circuit ground.
5) Monitor A4TP1 for clean sine wave, 70 V p-p nominal.
6) Leave setup for following check.
CHECK:
1) Setup as in preceeding check.
2) Replace A7.
3) Monitor A4TP1 for clean sine wave, 70 V p-p nominal.
4) Leave setup for following check.
PROBABLE CAUSE:
1) A4K1 or A4K2 shorted.
2) Low Frequency Output Network (A4) or T4.
3) CR1 or CR2 (on T4) shorted.
745A SETTING:
VOLTAGE RANGE . . . . . 10 V
Decades . . . . . 10.00000 V
Frequency . . . . . 590 Hz
CHECK:
1) Setup as in preceeding check (A6 removed).
2) Remove short from A2TP4 (leave A4K3 and K4 shorted).
3) Monitor OUTPUT for clean sine wave, 10.0 V rms.
4) Leave setup for following check.
PROBABLE CAUSE:
1) Shorted relays, drive transistors on A7.
2) Solder bridge or shorted contacts on A7 or XA7.
CHECK:
1) Setup as in preceeding check.
2) Remove shorts from across A4K3 and A4K4.
3) Monitor OUTPUT for clean sine wave, 10.0 V rms.
4) Leave setup for following check.
PROBABLE CAUSE:
1) A7Q13, A7A1 or + 5.2 V to A7.
2) Low Frequency Output Network (A4).
3) Output transformer (T4).
CHECK:
1) Setup as in preceeding check.
2) Replace A6.
3) Monitor OUTPUT for clean sine wave, 10.0 V rms.
4) If No Output, PROBABLE CAUSE: A6Q15 or shorted relay on A6.
5) If original symptom (No Output) has disappeared, check for intermittent relays or connections.
PROBABLE CAUSE: A4K3 or A4K4 open.
SYMPTOM: No Output, one VOLTAGE RANGE or group of VOLTAGE RANGES (such as 1 mV through 1 V ranges).
SYMPTOM: No Output, one or some VOLTAGE RANGE(S), all FREQUENCY RANGES.
PROBABLE CAUSE:
1) Corresponding VOLTAGE RANGE switching on A13.
2) Open flex cable from A13 (W2).
PROBABLE CAUSE: A6 (X1K and X10K) or A7 (X10 and X100) output relays or drive transistors for applicable VOLTAGE RANGES.
SYMPTOM: No Output, all VOLTAGE RANGES, one or some FREQUENCY RANGE(S).
CHECK:
1) Short A2TP4 to circuit ground.
2) Recheck COUNTER OUTPUT for clean sine wave, 1.6 V rms to 2.0 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
PROBABLE CAUSE:
1) A6A1 (X1K or X10K) or A7A1 (X10 or X100).
2) Open between XA14 and A6.
Go to Oscillator (A12) Troubleshooting (Figure 5-30)
SYMPTOM: No Output, all VOLTAGE RANGES, one or some decade setting(s).
PROBABLE CAUSE: Oscillator Output Attenuator (P/O A10 Schematic No. 13).
TRUE OR INDICATION CORRECT
FALSE OR INDICATION INCORRECT
745A-D-2337

NO OUTPUT (or OUTPUT <50%)

Figure 5-25. No Output Troubleshooting Tree

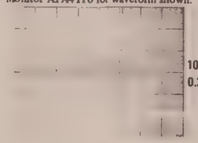

SYMPTOM: Output Error, no load (Load current < 10 mA).
An output error appearing on the 1 V through 100 V ranges may not be detectable on the millivolt ranges due to difficulty in measuring lower voltage levels. If the output error is present on the 1 V, 10 V and 100 V ranges, and is too slight to be detected on the millivolt ranges, consider the error present on all VOLTAGE RANGES.
TRUE OR INDICATION CORRECT
FALSE OR INDICATION INCORRECT
SYMPTOM: Output Error, all VOLTAGE RANGES, all FREQUENCY RANGES.
745A SETTING:
VOLTAGE RANGE .....1 V
Decades .....1.000000 V
CHECK:
1) Connect 22.1 ohm load across OUTPUT.
2) Short A2TP4 to circuit ground.
3) Monitor OUTPUT for clean sine wave (distortion < -68 dB nominal) 0.75 V rms to 0.95 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
CHECK:
1) Monitor any point on sixth Reference Divider transformer (A10T6) for clean 500 Hz square wave. Peak value of square wave should be equal to the decade setting (0.1 V to 1.1 V peak).
Go to A2/A3 Troubleshooting (Figure 5-28).
Go to Reference Square Wave Generator Troubleshooting (Figure 5-27).
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor COUNTER OUTPUT for clean sine wave (distortion < -66 dB nominal) 1.6 V rms to 2.0 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
Go to A4/A5 Troubleshooting (Figure 5-29).
Go to Oscillator (A12) Troubleshooting (Figure 5-30).
SYMPTOM: Output Error, all VOLTAGE RANGES, Hi (X1K and X10K) or Lo (X10 and X100) FREQUENCY RANGES only.
SYMPTOM: Output Error, all VOLTAGE RANGES, Hi (X1K and X10K) FREQUENCY RANGES only.
Go to Oscillator (A12) Troubleshooting (Figure 5-30).
745A SETTING:
VOLTAGE RANGE .....10 V
Decades .....10.00000 V
Frequency .....Set to frequency (Hi FREQ. RANGES only) where output error is present.
CHECK:
1) Remove A7.
2) Monitor OUTPUT for correct output voltage of 10.00000 V rms.
PROBABLE CAUSE:
1) Shorted or resistive relay on A7.
2) A7Q13 shorted.
PROBABLE CAUSE:
1) A4K1 or A4K2 open or resistive.
2) High frequency output network (A4) (A4C8 leaky or shorted).
3) A6 switching logic or output transformer.
SYMPTOM: Output Error, all VOLTAGE RANGES, Lo (X10 and X100) FREQUENCY RANGES only.
745A SETTING:
VOLTAGE RANGE .....1 V
Decades .....1.000000 V
Frequency .....500 Hz
CHECK:
1) Set ERROR MEASUREMENT control for 0 on % ERROR scale.
2) Remove A6.
3) Monitor OUTPUT for correct output voltage of 1.000000 V rms.
PROBABLE CAUSE:
1) Shorted relay on A6.
2) A6Q15 shorted.
PROBABLE CAUSE:
1) A4K3 or A4K4 open or resistive.
2) Low frequency output network (A4).
3) A7 switching logic.
4) Output transformer.
CHECK:
1) Set ERROR MEASUREMENT control for 0 on % ERROR scale.
2) Remove A6.
3) Monitor OUTPUT for correct output voltage of 1.000000 V rms.
PROBABLE CAUSE:
1) Resistive output or feedback relays on A5 or A7 for applicable VOLTAGE RANGE(S). Refer to Paragraph 5-151.
2) Bad OUTPUT or SENSE cables.
3) Poor internal connections to OUTPUT or SENSE terminals. (Check REAR OUTPUT connector-cap (P19).
4) Dirty contacts on A6 or A7 PC Assemblies.
5) Poor connections to output transformers.
PROBABLE CAUSE:
1) A13K1 or A13K2 shorted or resistive.
2) Short between inner and outer chassis.
SYMPTOM: Output Error, all VOLTAGE RANGES, one or some FREQUENCY RANGES(S).
745A SETTING:
VOLTAGE RANGE .....1 V
Decades .....1.000000 V
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor OUTPUT for clean sine wave (distortion < -68 dB nominal) 0.75 V rms to 0.95 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
Go to A2/A3 Troubleshooting (Figure 5-28).
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor COUNTER OUTPUT for clean sine wave (distortion -66 dB nominal) 1.6 V rms to 2.0 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
Go to A4/A5 Troubleshooting (Figure 5-29).
Go to Oscillator Troubleshooting (Figure 5-30).
SYMPTOM: Output Error on all but one VOLTAGE RANGE.
PROBABLE CAUSE:
1) Shorted relay or drive transistor (A6 or A7) common to VOLTAGE RANGE with correct output.
SYMPTOM: Output Error, all VOLTAGE RANGES, one or some voltage setting(s).
PROBABLE CAUSE:
1) A3Q15, A3Q1 through A3Q3 (output error at 10% of range).
2) Reference Divider (P/O A10)
3) Oscillator Output Attenuator (P/O A10).
4) Thermocouple Driver Gain Control (P/O A10).
SYMPTOM: Output Error, one or some VOLTAGE RANGE(S).
PROBABLE CAUSE:
1) Resistive (or open) output or feedback relays on A6 or A7 for applicable VOLTAGE RANGE(S). Refer to Paragraph 5-151.
SYMPTOM: Poor Load Regulation.
745A SETTING:
VOLTAGE RANGE .....1 V
Decades .....1.000000 V
CHECK:
1) Connect 22.1 ohm load across OUTPUT.
2) Short A2TP4 to circuit ground.
3) Monitor OUTPUT for clean sine wave, (distortion < -68 dB nominal) 0.75 V rms to 0.95 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
NOTE:
If poor load regulation is caused by capacitive loading at high frequencies, repeat the above check using an 800 pF load capacitor in place of the 22.1 ohm load resistor. Set 745A VOLTAGE RANGE to 100 V, monitor OUTPUT for clean sine wave, 80 V rms to 115 V rms, all FREQUENCY RANGES and FREQUENCY dial settings.
CHECK:
1) Turn LINE switch OFF.
2) Disconnect external OUTPUT and SENSE leads. Disconnect ground strap.
3) Disconnect power cord and all test equipment connected to circuit ground.
4) Measure resistance between HI OUTPUT and HI SENSE and between LO OUTPUT and LO SENSE. Resistance should be >100 Megohms.
5) Measure resistance between LO SENSE and outer chassis ground (100 Megohms).
Go to A4/A5 Troubleshooting (Figure 5-29).
745A-D-2339

OUTPUT ERROR (or Poor Load Regulation or Instability)

Figure 5-26. Output Error Troubleshooting Tree

CHECK:
1) Set A1A4S1 to -9.9 V position.
2) Connect dc differential voltmeter (hp-3420A/B) to A1A3TP5.
3) Adjust A1A3R34 (1) for -9.9 Vdc ± 10 μV.

- CHECK:
  1) Select 0 ERROR RANGE.
  2) Set A1A4S1 to +9.9 V position.
  3) Connect dc differential voltmeter (-hp-3420A/B) to A1A3TP5.
  4) Adjust A1A3R16 (1) and A1A3R14 for +9.9 Vdc ± 10 μV.
  5) Vary ERROR MEASUREMENT control from +3 to -3. +9.9 V should not vary more than ± 20 μVdc.
  - CHECK:
    1) Set A1A4S1 to center (19.8 V p-p) position.
    2) Monitor A1A3TP5 for clean, 500 Hz square wave, 19.8 V p-p.
    - 745A SETTING:
      Decades 1.000000
      CHECK:
      1) Monitor any point on sixth Reference Divider transformer (A10T6) for clean 500 Hz square wave 2 V p-p.
      2) Vary decade setting. Peak value of square wave should be equal to decade setting (0.1 V pk to 1.1 V pk).
      - Recheck original symptoms or perform basic check outlined in Paragraph 5-131.
      - 745A SETTING:
        Decades 1.000000
        CHECK:
        Monitor square-wave input to A10 at A10J2 for clean, 500 Hz square wave 2.2 V p-p.
        - PROBABLE CAUSE: Reference Divider (P/O A10 Schematic No. 13).
        - PROBABLE CAUSE: T1 (9:1 divider) C1, L1 or cabling between T1 and A10.
    - CHECK:
      Monitor A1A4TP6 for waveform shown.

      - PROBABLE CAUSE: A1A4Q3 through A1A4Q5
      - PROBABLE CAUSE: A1A4Q1 or A1A4Q2
  - SYMPTOM:
    +9.9 V varies more than ± 20 μVdc as ERROR MEASUREMENT control is varied from +3 to -3 on 0 ERROR RANGE.
    - PROBABLE CAUSE:
      1) A1A4K1 or A1A4K2 open or resistive.
      2) A6Q13 or A6Q14
      3) ERROR RANGE switching circuits on A13.
      4) Open trace on Flex-cable (W2).
    - CHECK:
      Measure dc voltage at A1A1TP1 for +15 V ± 0.05 Vdc.
      - PROBABLE CAUSE:
        1) A1A3Q1 through A1A3Q6
        2) A1A2Q5 (not field replaceable)
      - Refer to Power Supply Troubleshooting (Paragraph 5-133).
- CHECK:
  Measure dc voltage at A1A1TP2 for -15 V ± 0.05 Vdc.
  - PROBABLE CAUSE:
    1) A1A3Q1 through A1A3Q12
    2) A1A2A1Q4 (not field replaceable)
  - Refer to Power Supply Troubleshooting (Paragraph 5-133).

TRUE OR INDICATION CORRECT

FALSE OR INDICATION INCORRECT

745A-D-2340

Figure 5-27. Reference Square Wave Generator (A1) Troubleshooting Tree

SYMPTOM:
Output Error, all VOLTAGE RANGES, all FREQUENCY RANGES.

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745A SETTING:
VOLTAGE RANGE .....1 V
Decades .....1.000000 V
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor OUTPUT for clean sine wave (distortion < -68 dB nominal) 0.75 V rms to 0.95 V rms all FREQUENCY RANGES and FREQUENCY dial settings.

745A SETTING:
Decades 1.000000
Frequency .....1 kHz
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor collector of A3Q3 for waveform shown.

745A SETTING:
VOLTAGE RANGE .....1 V
Decades .....1.000000 V
Frequency .....50 kHz
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor A3TP1 for clean sine wave (15 V p-p nom.)/square wave (12 V p-p nom.) samples (switching at 2 Hz rate).

745A SETTING:
Frequency .....1 kHz
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor A2TP1 for clean sine wave (3 V p-p nom.)/square wave (2.5 V p-p nom.) samples.
3) Vary first two decade settings. Signal amplitude at A2TP1 should remain constant.

745A SETTING:
Decades 1.000000
Frequency .....1 kHz
CHECK:
Adjust A2R34 ⓘ for +0.6 Vdc at A2TP2.

PROBABLE CAUSE:
1) A2Q1 through A2Q7
2) Thermocouple Driver Gain Control, A10W2 or A10W3 (Schematic No. 13).

745A SETTING:
Decades 1.000000
CHECK:
1) Remove Sampling Amplifier Assy. (A3).
2) Measure dc voltage at A2TP2 for +0.4 Vdc nominal.
3) Replace A3.

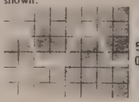
PROBABLE CAUSE:
1) A2Q8 through A2Q12
2) A2CR4, A2CR7

745A SETTING:
VOLTAGE RANGE .....1 V
Decades 1.000000
Frequency .....1 kHz
SENSE .....REMOTE
CHECK:
1) Disconnect OUTPUT and SENSE leads.
2) Monitor junction of A2Q21, A2Q22 and A2R60 for waveform shown.
3) Leave setup for following check.

PROBABLE CAUSE:
1) A2TC1 open
2) A2Q8 through A2Q12

CHECK:
1) Short A2TP3 to circuit grou
2) Measure dc voltage at A2TP
3) Vary A2R67 Ⓡ Voltage
vary from approximately
fully CCW) to +0.5 Vdc (R

CHECK:
1) Setup as in preceeding check
2) Monitor base of A2Q17
shown.



745A SETTING:
Decades 1.000000
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor A3 pin 9 for clean sine wave 2.5 V p-p (nominal), all FREQUENCY RANGES and FREQUENCY dial settings.

Go to Reference Square Wave Generator (A1) Troubleshooting (Figure 5-27).

745A SETTING:
Frequency .....1 kHz
CHECK:
Monitor A3 pin 12 for 2 Hz sample gate, 30 V p-p nominal.

PROBABLE CAUSE:
1) REAR OUTPUT connector cap (P19)
2) A13K1, A13K2 (Schematic No. 20)
3) A3CR11, A3CR12

745A SETTING:
Frequency .....1 kHz
Decades 1.000000
CHECK:
1) Short A2TP4 to circuit ground.
2) Remove A3R50.
3) Monitor gate of A3Q15A for sine wave (2.5 V p-p nom.)/square wave (1.9 V p-p. nom.) sample (2 Hz sample rate).

PROBABLE CAUSE:
A3Q15 through A3Q23

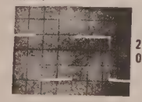
PROBABLE CAUSE:
1) A3Q11 through A3Q14
2) A3Q15 shorted

745A SETTING:
Frequency .....1 kHz
CHECK:
Monitor collectors of A3Q9 and A3Q10 for 2 Hz sample gate 14 V p-p nominal.

PROBABLE CAUSE:
A3Q4 through A3Q6

745A SETTING:
Frequency .....
CHECK:
Monitor emitter of A3Q8 for

745A SETTING:
Decades 1.000000
Frequency .....1 kHz
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor collector of A3Q1A for waveform shown.



PROBABLE CAUSE: A3Q2, A3Q3

PROBABLE CAUSE: A3Q1

CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor COUNTER OUTPUT for clean sine wave (distortion < -66 dB nominal) all FREQUENCY RANGES and FREQUENCY dial settings.

Go to A4/A5 Troubleshooting (Figure 5-29).

Go to Oscillator (A12) Troubleshooting (Figure 5-30).

SYMPTOM:
Output Error, X10 FREQUENCY RANGE *only*.

745A SETTING:
Decades 1.000000
FREQUENCY RANGE X10
CHECK:
Monitor A3TP1 for sine wave/square wave sample, 1 Hz sample rate.

PROBABLE CAUSE: A2K1, A2C13.

PROBABLE CAUSE: A3K1, A3C6.

Go to Point A.

TRUE OR INDICATION CORRECT

FALSE OR INDICATION INCORRECT

745A-D-2343

745A SETTING:
VOLTAGE RANGE ..... 1 V
Decades ..... 1.000000 V
CHECK:
1) Connect 22.1 ohm load across OUTPUT.
2) Short A2TP4 to circuit ground.
3) Monitor OUTPUT for clean sine wave (distortion < −68 dB nominal) 0.75 V rms to 0.95 V rms all FREQUENCY RANGES and FREQUENCY dial settings.

Recheck Original Symptom.

CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor COUNTER OUTPUT for clean sine wave (distortion < −66 dB nominal) 1.6 V rms to 2.0 V rms, all FREQUENCY RANGES and FREQUENCY dial settings.

745A SETTING:
VOLTAGE RANGE ..... 1 V
Decades ..... 1.000000 V
Frequency ..... 1 kHz
CHECK:
Adjust A4R8 Ⓜ for 0 V ± 3 mVdc at A4TP1.

Go to Oscillator Troubleshooting (Figure 5-30).

745A SETTING:
Decades ..... 1.000000 V
Frequency ..... 1 kHz
CHECK:
1) Remove Power Amplifier (A5).
2) Monitor A4TP2 for signal 1.1 V p-p nominal.
3) Replace A5.

CHECK:
Measure dc voltage at A8TP3 (−70 V ± 3 Vdc) and A8TP4 (+70 V ± 3 Vdc).

CHECK:
Measure dc voltage on collector of A4Q4 (−11.3 Vdc nominal).

745A SETTING:
Decades ..... 1.000000 V
CHECK:
1) Remove Preamplifier Assy. (A4).
2) Short A2TP4 to circuit ground.
3) Monitor A4 pin 14 for clean sine wave, 4.8 V p-p to 5.4 V p-p (nominal) all FREQUENCY RANGES and FREQUENCY dial settings.

CHECK:
1) Remove A4Q1.
2) Recheck 745A OUTPUT for original symptom.
3) If original symptom is *not present*, probable cause: A4Q1.

PROBABLE CAUSE: A4Q4, A4CR1.

Go to Point A.

CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor junction of A14L2 and A14C2 for clean sine wave, 4.8 V p-p to 5.4 V p-p (nominal) all FREQUENCY RANGES and FREQUENCY dial settings.

NOTE:
A14L2 and A14C2 are located directly below A10 Assembly on the Mother Board (A14).

PROBABLE CAUSE:
Oscillator Output Attenuator (P/O A10 Schematic No. 13) or cable A10W1 between A10 and P1.

PROBABLE CAUSE:
1) L2 open or open flex cable (W2) between XA14 Pin 1 and Oscillator output.
2) If signal is present at junction of L2 and C2 but rolls-off at high frequencies, check A12A8L1 thru A12A8L3 for cracked castings; check A12A8C16 and associated circuitry.

PROBABLE CAUSE: A4Q1, A5Q11, A5Q12

745A SETTING:
Decades ..... 1.000000 V
CHECK:
Monitor junction of A4R28 and A4C3 for ac signal *less than* 0.05 V p-p, all FREQUENCY RANGES and FREQUENCY dial settings.

745A SETTING:
Decades ..... 1.000000 V
CHECK:
Monitor ac signal at A5 pin 15 and A5 pin 18. Signal should be *less than* 0.08 V p-p, all FREQUENCY RANGES, all FREQUENCY dial settings.

PROBABLE CAUSE: A4C3 open.

CHECK:
1) Adjust A4R8 Ⓜ for 0 V ± 3 mVdc at A4TP1.
2) Recheck OUTPUT for original symptom.
3) If original symptom remains, troubleshoot A4/A5 by checking dc voltages and waveforms on Schematic No's. 7 and 8.
4) If dc voltages are correct, PROBABLE CAUSE:
1) Leakage between A5 transistor mounting bracket and collector of A5Q1, A5Q2, A5Q9 or A5Q10.
2) Leakage between collector of Q6 (on mainframe) and circuit ground.
3) Open shaping or bypass capacitors on A4 or A5.
4) Breakdown or other transistor failure that occurs under dynamic conditions (check by replacing suspected components).

PROBABLE CAUSE:
1) A5C2 or A5C3 open.
2) If signal (previous check) is 120 Hz ripple, check + 70 V or −70 V filter capacitor on A9 Assembly (Schematic No. 12).

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CHECK:
Measure dc voltage at A12A8TP2 (+ 0.2 Vdc to + 0.3 Vdc).

CHECK:
1) Remove the A6 and A7 Switching Assemblies.
2) Short bases of A4Q2A and A4Q2B to circuit ground.
3) Measure dc voltage at A4 pin 22. Vary A4R8 Ⓜ ; dc voltage (pin 22) should vary from approximately −66 Vdc (R8 fully CCW) to −59 Vdc (R8 fully CW).
4) Leave setup for following check.

Refer to Paragraph 5-73.

CHECK:
1) Setup as in preceeding check.
2) Adjust A4R8 Ⓜ for 0 Vdc on collector of A5Q1.
3) Leave setup for following check.

CHECK:
Adjust A4R8 Ⓜ for equal dc voltage on collectors of A4Q6 and A4Q7 (−14 Vdc nominal).

CHECK:
1) Setup as in preceeding check.
2) Short bases of A5Q3 and A5Q4 to circuit ground.
3) Troubleshoot Power Amplifier by checking for dc voltages shown on Schematic No. 8.

PROBABLE CAUSE: A5Q1.

PROBABLE CAUSE: A4Q9, A4Q10, A5Q1.

CHECK:
Measure dc voltage on collector of A4Q4 (−11.3 Vdc nominal).

CHECK:
Adjust A4R8 Ⓜ for equal dc voltage on collectors of A4Q3A and A4Q3B (+ 6.1 Vdc nominal).

PROBABLE CAUSE: A4Q5, A4Q6

PROBABLE CAUSE: A4Q2, A4Q3

PROBABLE CAUSE: A4Q4, A4CR1.

CHECK:
1) Remove Power Amplifier (A5).
2) Recheck ± 70 V supplies at A8TP3 and A8TP4.

CHECK:
1) Remove A6 and A7 Switching Assemblies.
2) Short bases of A4Q2A and A4Q2B to circuit ground.
3) Replace Power Amplifier (A5).
4) Recheck ± 70 V supplies at A8TP3 and A8TP4.

Go to Point A.

PROBABLE CAUSE:
1) A5C2 or A5C3 shorted.
2) A4K1 or A4K3 (contacts) shorted.
3) Other low resistance path between + 70 V or −70 V and circuit ground on A5.

CHECK:
1) Remove Preamplifier Assy. (A4).
2) Recheck ± 70 V supplies at A8TP3 and A8TP4.

PROBABLE CAUSE:
1) ± 70 V interlocks on A4 pins 16, 17, 19 and 20.
2) A4Q10 or associated circuitry.

PROBABLE CAUSE:
+ 70 V or −70 V power supplies (A8 or A9 Assemblies). Refer to Paragraph 5-133 for troubleshooting data.

TRUE OR INDICATION CORRECT

FALSE OR INDICATION INCORRECT

745A-D-2344

Figure 5-29. Preamplifier and Power Amplifier (A4/A5) Troubleshooting Tree

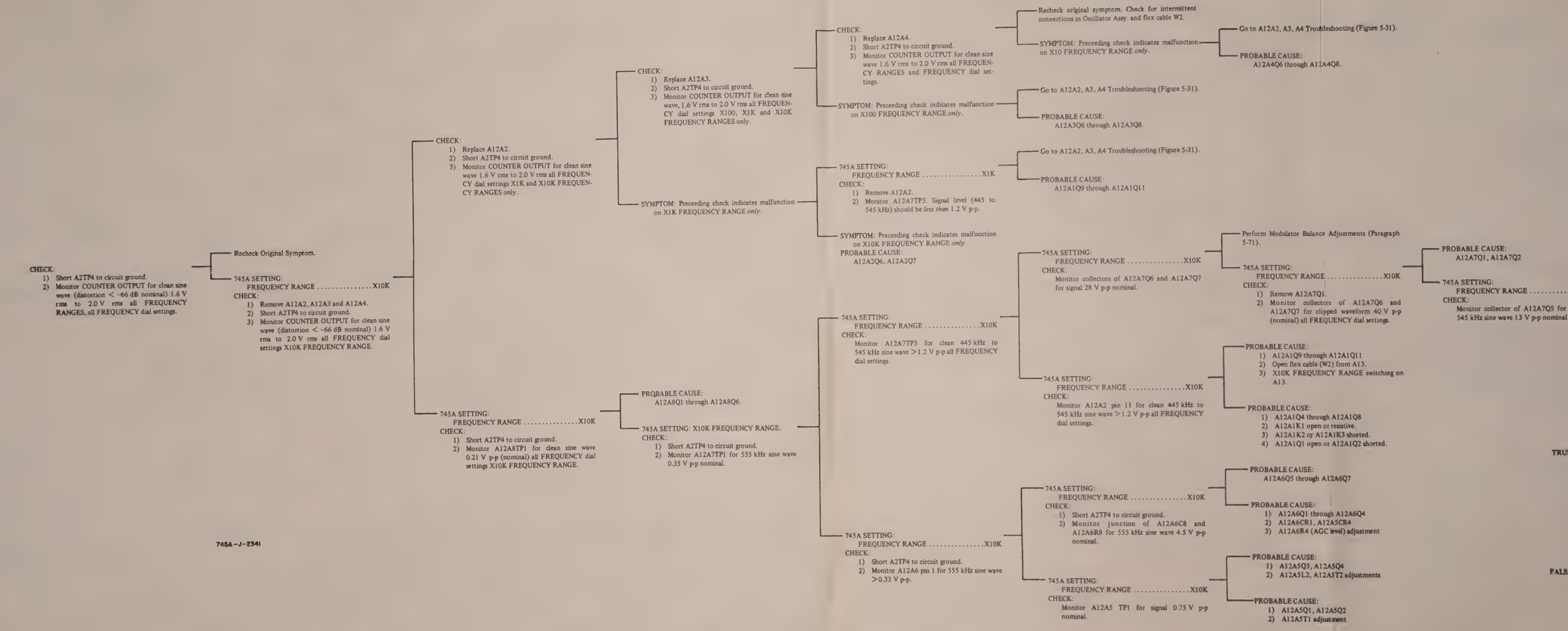

CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor COUNTER OUTPUT for clean sine wave (distortion < -66 dB nominal) 1.6 V rms to 2.0 V rms all FREQUENCY RANGES, all FREQUENCY dial settings.
Recheck Original Symptom.
745A SETTING: FREQUENCY RANGE X10K
CHECK:
1) Remove A12A2, A12A3 and A12A4.
2) Short A2TP4 to circuit ground.
3) Monitor COUNTER OUTPUT for clean sine wave (distortion < -66 dB nominal) 1.6 V rms to 2.0 V rms all FREQUENCY dial settings X10K FREQUENCY RANGE.
CHECK:
1) Replace A12A2.
2) Short A2TP4 to circuit ground.
3) Monitor COUNTER OUTPUT for clean sine wave 1.6 V rms to 2.0 V rms all FREQUENCY dial settings X1K and X10K FREQUENCY RANGES only.
CHECK:
1) Replace A12A3.
2) Short A2TP4 to circuit ground.
3) Monitor COUNTER OUTPUT for clean sine wave, 1.6 V rms to 2.0 V rms all FREQUENCY dial settings X100, X1K and X10K FREQUENCY RANGES only.
CHECK:
1) Replace A12A4.
2) Short A2TP4 to circuit ground.
3) Monitor COUNTER OUTPUT for clean sine wave 1.6 V rms to 2.0 V rms all FREQUENCY RANGES and FREQUENCY dial settings.
Recheck original symptom. Check for intermittent connections in Oscillator Assy. and flex cable W2.
SYMPTOM: Preceeding check indicates malfunction on X10 FREQUENCY RANGE only.
Go to A12A2, A3, A4 Troubleshooting (Figure 5-31).
PROBABLE CAUSE: A12A4Q6 through A12A4Q8.
SYMPTOM: Preceeding check indicates malfunction on X100 FREQUENCY RANGE only.
Go to A12A2, A3, A4 Troubleshooting (Figure 5-31).
PROBABLE CAUSE: A12A3Q6 through A12A3Q8.
SYMPTOM: Preceeding check indicates malfunction on X1K FREQUENCY RANGE only.
745A SETTING: FREQUENCY RANGE X1K
CHECK:
1) Remove A12A2.
2) Monitor A12A7TP3. Signal level (445 to 545 kHz) should be less than 1.2 V p-p.
Go to A12A2, A3, A4 Troubleshooting (Figure 5-31).
PROBABLE CAUSE: A12A1Q9 through A12A1Q11
SYMPTOM: Preceeding check indicates malfunction on X10K FREQUENCY RANGE only.
PROBABLE CAUSE: A12A2Q6, A12A2Q7
745A SETTING: FREQUENCY RANGE X10K
CHECK:
Monitor A12A7TP3 for clean 445 kHz to 545 kHz sine wave >1.2 V p-p all FREQUENCY dial settings.
745A SETTING: FREQUENCY RANGE X10K
CHECK:
Monitor collectors of A12A7Q6 and A12A7Q7 for signal 28 V p-p nominal.
Perform Modulator Balance Adjustments (Paragraph 5-71).
745A SETTING: FREQUENCY RANGE X10K
CHECK:
1) Remove A12A7Q1.
2) Monitor collectors of A12A7Q6 and A12A7Q7 for clipped waveform 40 V p-p (nominal) all FREQUENCY dial settings.
PROBABLE CAUSE: A12A7Q1, A12A7Q2
745A SETTING: FREQUENCY RANGE X10K
CHECK:
Monitor collector of A12A7Q5 for 445 kHz to 545 kHz sine wave 13 V p-p nominal.
PROBABLE CAUSE: A12A7Q6 through A12A7Q8
PROBABLE CAUSE: A12A7Q3 through A12A7Q5
745A SETTING: FREQUENCY RANGE X10K
CHECK:
Monitor A12A2 pin 11 for clean 445 kHz to 545 kHz sine wave >1.2 V p-p all FREQUENCY dial settings.
PROBABLE CAUSE:
1) A12A1Q9 through A12A1Q11
2) Open flex cable (W2) from A13.
3) X10K FREQUENCY RANGE switching on A13.
PROBABLE CAUSE:
1) A12A1Q4 through A12A1Q8
2) A12A1K1 open or resistive.
3) A12A1K2 or A12A1K3 shorted.
4) A12A1Q1 open or A12A1Q2 shorted.
745A SETTING: FREQUENCY RANGE X10K
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor A12A6 pin 1 for 555 kHz sine wave >0.33 V p-p.
745A SETTING: FREQUENCY RANGE X10K
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor junction of A12A6C8 and A12A6R8 for 555 kHz sine wave 4.5 V p-p nominal.
PROBABLE CAUSE: A12A6Q5 through A12A6Q7
PROBABLE CAUSE:
1) A12A6Q1 through A12A6Q4
2) A12A6CR1, A12A5CR4
3) A12A6R4 (AGC level) adjustment
745A SETTING: FREQUENCY RANGE X10K
CHECK:
Monitor A12A5 TP1 for signal 0.75 V p-p nominal.
PROBABLE CAUSE:
1) A12A5Q3, A12A5Q4
2) A12A5L2, A12A5T2 adjustments
PROBABLE CAUSE:
1) A12A5Q1, A12A5Q2
2) A12A5T1 adjustment
745A SETTING: FREQUENCY RANGE X10K
CHECK:
Monitor A12A8TP1 for clean sine wave 0.21 V p-p (nominal) all FREQUENCY dial settings X10K FREQUENCY RANGE.
PROBABLE CAUSE: A12A8Q1 through A12A8Q6.
745A SETTING: X10K FREQUENCY RANGE.
CHECK:
1) Short A2TP4 to circuit ground.
2) Monitor A12A7TP1 for 555 kHz sine wave 0.35 V p-p nominal.
TRUE OR INDICATION CORRECT
FALSE OR INDICATION INCORRECT
745A-J-2341

Figure 5-30. Oscillator Troubleshooting Tree

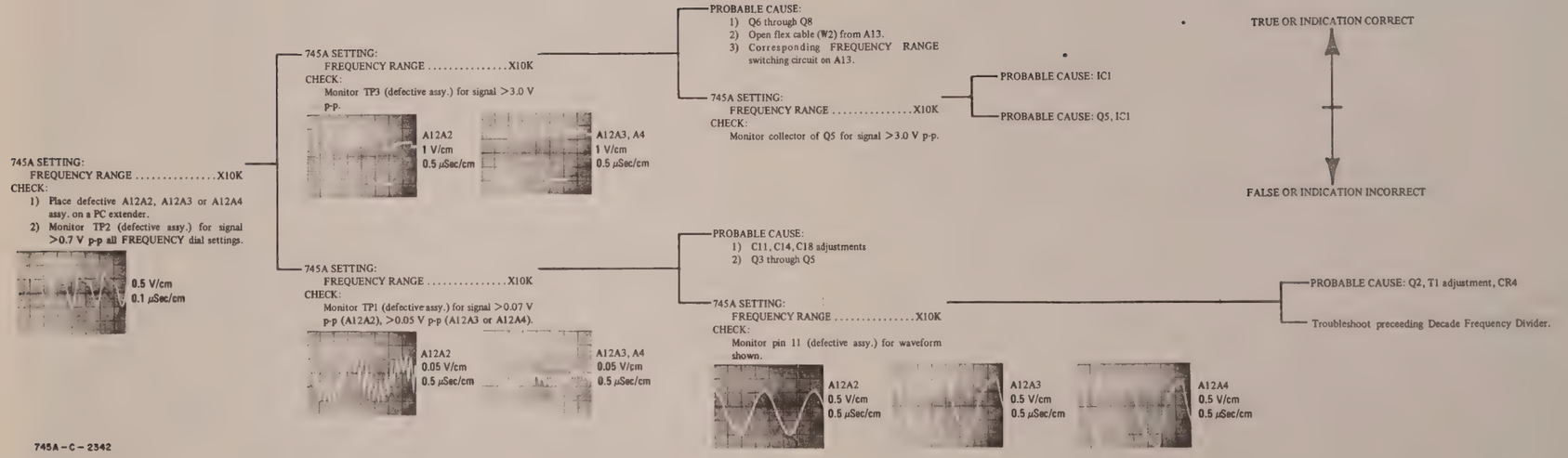
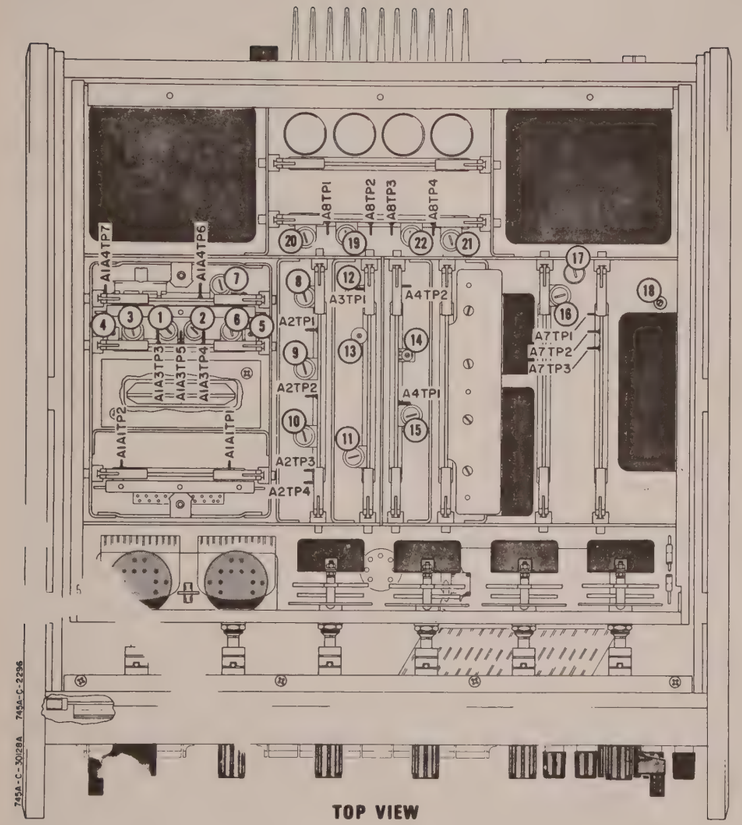
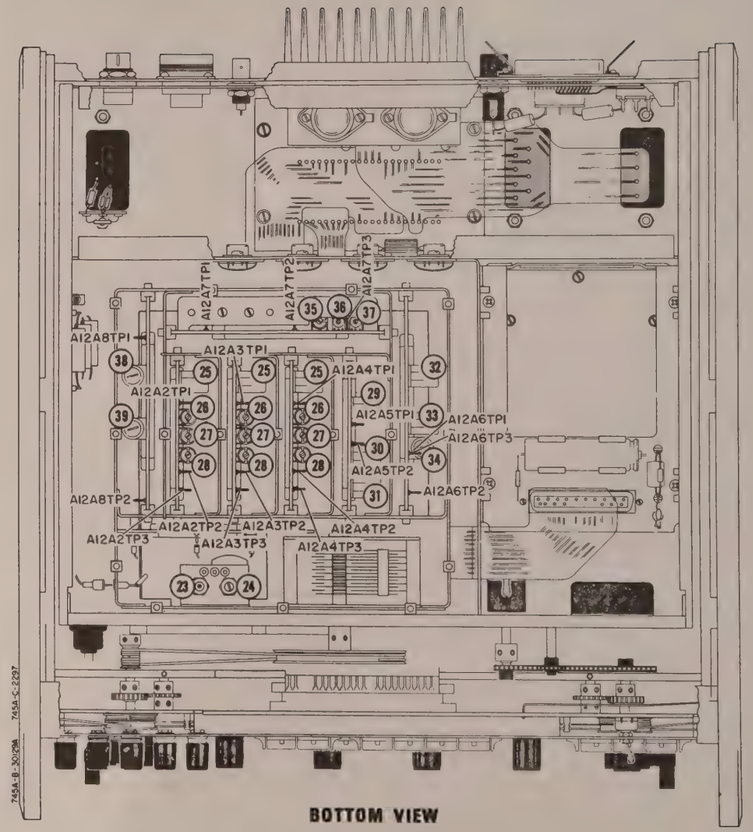


Figure 5-31. Decade Frequency Divider Troubleshooting Tree



TOP VIEW



BOTTOM VIEW

Figure 5-32. Adjustment Locations (Top View)

Figure 5-33. Adjustment Locations (Bottom View)

SECTION VI
REPLACEABLE PARTS

INTRODUCTION.

This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, hp-part number of each part, together with any applicable Mfr. code, and provides the following:

a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

d. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, find the manufacturer's part number and description in this manual and then refer to the appropriate Repair Parts and Special Tools List (RPSTL) TM. In the RPSTL, find the assembly or subassembly first and then the description which corresponds with that in this manual. Under the description in the RPSTL find the manufacturer's part number, and then order the part by the listed Federal Stock Number. If the part is not listed in the RPSTL, it should be requisitioned from the Army Metrology and Calibration Center (AMSMI-MFM) in accordance with SB 9-170.

ABBREVIATIONS

	...silver
	...aluminum
	...ampere(s)
	...gold
	...capacitor
	...ceramic
	...coefficient
	...common
	...composition
	...connection
	...deposited
DT	...double-pole double-throw
ST	...double-pole single-throw
	...electrolytic
	...encapsulated
	...farad(s)
T	...field effect transistor
	...fixed
As	...gallium arsenide
	...gigahertz = 10^{+9} hertz
	...guard(ed)
	...germanium
	...ground(ed)
	...henry(ies)
	...mercury
	...hertz (cycle(s) per second)
ID	...inside diameter
impg	...impregnated
incd	...incandescent
ins	...insulation(ed)
kΩ	...kilohm(s) = 10^{+3} ohms
kHz	...kilohertz = 10^{+3} hertz
L	...inductor
lin	...linear taper
log	...logarithmic taper
mA	...milliampere(s) = 10^{-3} amperes
MHz	...megahertz = 10^{+6} hertz
MΩ	...megohm(s) = 10^{+6} ohms
met flm	...metal film
mfr	...manufacturer
ms	...millisecond
mtg	...mounting
mV	...millivolt(s) = 10^{-3} volts
μF	...microfarad(s)
μs	...microsecond(s)
μV	...microvolt(s) = 10^{-6} volts
my	...Mylar (R)
nA	...nanoampere(s) = 10^{-9} amperes
NC	...normally closed
Ne	...neon
NO	...normally open
NPO	...negative positive zero (zero temperature coefficient)
ns	...nanosecond(s) = 10^{-9} seconds
nsr	...not separately replaceable
Ω	...ohm(s)
obd	...order by description
OD	...outside diameter
p	...peak
pA	...picoampere(s)
pc	...printed circuit
pF	...picofarad(s) 10^{-12} farads
piv	...peak inverse voltage
p/o	...part of
pos	...position(s)
poly	...polystyrene
pot	...potiometer
p-p	...peak-to-peak
ppm	...parts per million
prec	...precision (temperature coefficient, long term stability, and/or tolerance)
R	...resistor
Rh	...rhodium
rms	...root-mean-square
rot	...rotary
Se	...selenium
sect	...section(s)
Si	...silicon
sl	...slide
SPDT	...single-pole double-throw
SPST	...single-pole single-throw
Ta	...tantalum
TC	...temperature coefficient
TiO_2	...titanium dioxide
tog	...toggle
tol	...tolerance
trim	...trimmer
TSTR	...transistor
V	...volt(s)
vacw	...alternating current working voltage
var	...variable
vdcw	...direct current working voltage
W	...watt(s)
w/	...with
wiv	...working inverse voltage
w/o	...without
ww	...wirewound
*	...optimum value selected at factory, average value shown (part may be omitted)
**	...no standard type number assigned (selected or special type

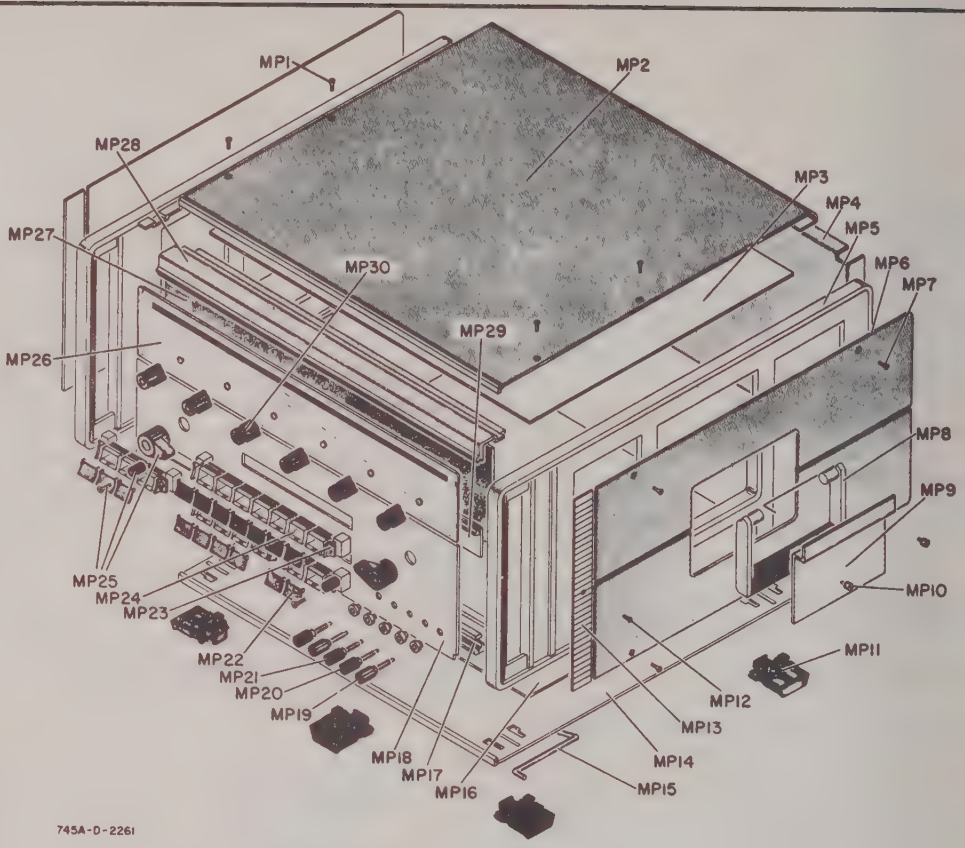
(R) Dupont de Nemours

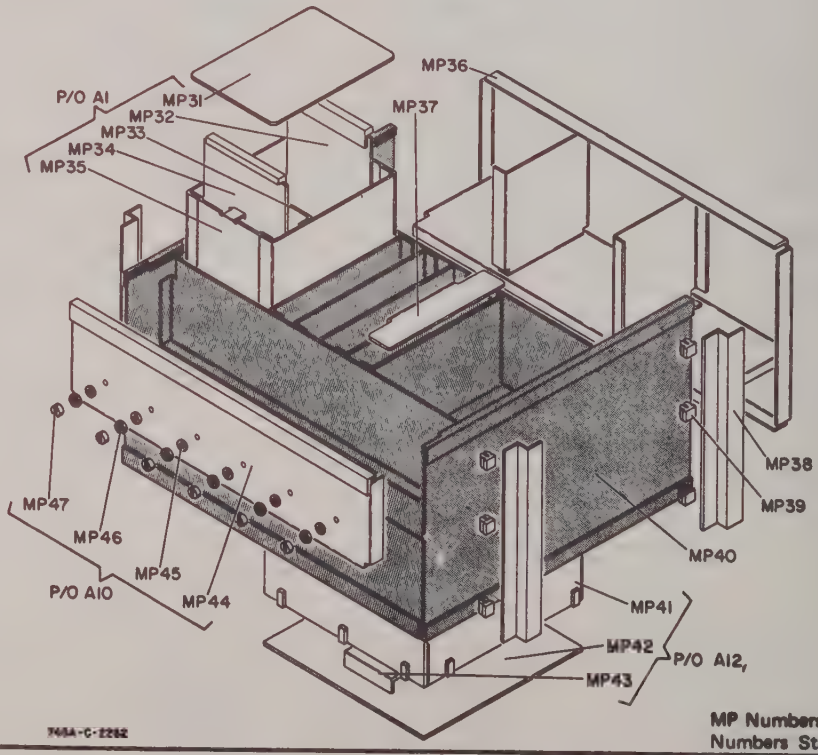
DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

DESIGNATORS

	...assembly
	...motor
	...battery
	...capacitor
	...diode
	...delay line
	...lamp
	...misc electronic part
	...fuse
FL	...filter
HR	...heater
IC	...integrated circuit
J	...jack
K	...relay
L	...inductor
M	...meter
MP	...mechanical part
P	...plug
Q	...transistor
QCR	...transistor-diode
R	...resistor
RT	...thermistor
S	...switch
T	...transformer
TB	...terminal board
TC	...thermocouple
TP	...test point
TS	...terminal strip
V	...vacuum tube, neon bulb, photocell, etc.
W	...cable
X	...socket
XDS	...lampholder
XF	...fuseholder
Y	...crystal
Z	...network





MP Numbers Coordinate With MP Numbers Starting On Page 6-32.

Figure 6-1. Mechanical Parts

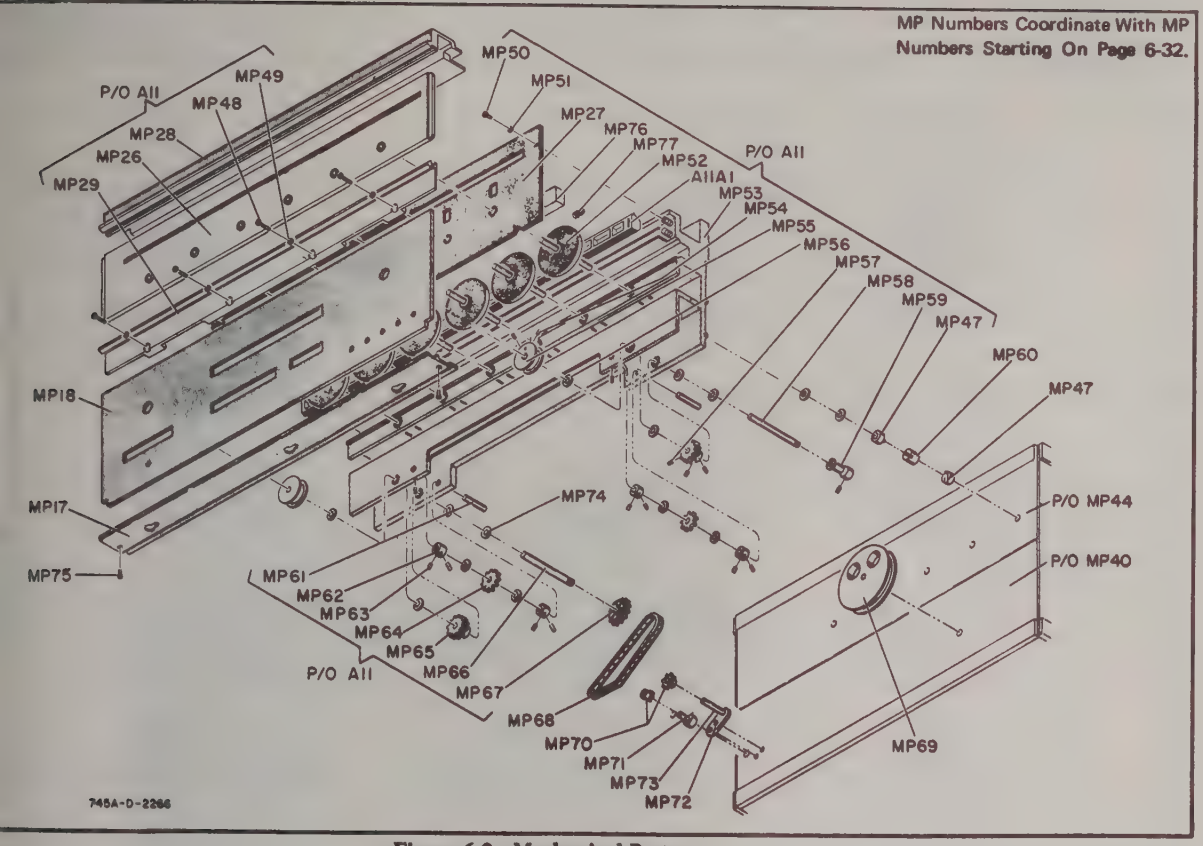


Figure 6-2. Mechanical Parts

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	**00745-66940**		**PC Ass'y: Reference Square Wave Generator**	**-hp-**	
	00745-66546	1	PC Ass'y: Mother Board only	-hp-	
1	1251-1969	1	Body: 37 contact (does not include pins)	74868	17-307-01
	1251-1971	17	Pin: male dip solder (for A1P1)	74868	17-552-02
1	0686-2415	1	R: fxd comp 240 ohms 5% 1/2 W	01121	EB 2415
XA1A1	1251-1558	10	Connector: pc 15 (1 x 15)	71785	252-15-30-350
XA1A2	1251-1962	3	Connector: pc 20 (2 x 10)	71785	252-10-30-330
XA1A3, XA1A4	1251-1558		Connector: pc 15 (1 x 15)	71785	252-15-30-350

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1A1	**00745-66541**		**PC Ass'y: ±15 V Power Supply**	**-hp-**	
C1	0160-0024	1	C: fxd cer 0.02 uF +80% -20% 600 vdcw	72982	841-000-Z5U-203Z
C2	0180-0374	1	C: fxd Ta elect 10 uF 10% 20 vdcw	56289	150D106X9020B2-DYS
C3	0180-0286	2	C: fxd Al elect 500 uF +75% -10% 25 vdcw	56289	D38774-DSB (Type 34D
C4	0140-0171	1	C: fxd mica 0.01 uF 10% 300 vdcw	72136	RDM30F103K3S
C5	0140-0159	1	C: fxd mica 0.003 uF 2% 300 vdcw	14655	RDM19F302G3S
C8	0180-0286		C: fxd Al elect 500 uF +75% -10% 25 vdcw	56289	D38774-DSB (Type 34D)
CR1, CR2	1901-0158	11	Diode: Si 200 piv 0.75 A	04713	SR1358-3
Q1	1854-0072	2	TSTR: Si NPN 2N3054	86684	2N3054
Q2 thru Q7	1854-0033	17	TSTR: Si NPN 2N3391	07263	S3620
Q8	1854-0072		TSTR: Si NPN 2N3054	86684	2N3054
Q9 thru Q12	1854-0033		TSTR: Si NPN 2N3391	07263	S3620
R1	0698-4500	1	R: fxd met film 57.6 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R2	0757-0446	11	R: fxd met film 15 kilohms 1% 1/8 W	75042	CEA T-O
R3	0757-0280	21	R: fxd met film 1000 ohms 1% 1/8 W	14674	C4 T-O
R4	0757-0426	3	R: fxd met film 1300 ohms 1% 1/8 W	14674	C4 T-O
R5	0811-2466	2	R: fxd ww 1.2 ohms 5% 1/2 W	75042	BW-20 Rev. A
R6	0698-4123	4	R: fxd met film 499 ohms 1% 1/8 W	14674	C4 T-O
R7	0698-4470	3	R: fxd met 6980 ohms 1% 1/8 W	75042	CEA T-O
R8	0757-0442	21	R: fxd met film 10 kilohms 1% 1/8 W	14674	C4 T-O
R9	0698-3279	2	R: fxd met film 4990 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R10	0698-4121	1	R: fxd met film 11.3 kilohms 1% 1/8 W	14674	C4 T-O
R11	0757-0449	3	R: fxd met film 20 kilohms 1% 1/8 W	14674	C4 T-O
R12	0698-4475	1	R: fxd met film 9760 ohms 1% 1/8 W	75042	CEA T-O
R13, R14	0811-2464	2	R: fxd prec ww 3000 ohms 0.1% 1/8 W	-hp-	
R15	0757-0446		R: fxd met film 15 kilohms 1% 1/8 W	75042	CEA T-O
R16, R17	0757-0426		R: fxd met film 1300 ohms 1% 1/8 W	14674	C4 T-O
R18	0811-2466		R: fxd ww 1.2 ohms 5% 1/2 W	75042	BW-20 Rev. A
R19	0757-0407	8	R: fxd met film 200 ohms 1% 1/8 W	14674	C4 T-O
R20	0698-4470		R: fxd met 6980 ohms 1% 1/8 W	75042	CEA T-O
R21, R22	0757-0446		R: fxd met film 15 kilohms 1% 1/8 W	75042	CEA T-O
R23	0757-0467	3	R: fxd met film 121 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R24	0698-4505	3	R: fxd met film 71.5 kilohms 1% 1/8 W	14674	C4 T-O
R25	0757-0467		R: fxd met film 121 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R26	0757-0453	2	R: fxd met film 30.1 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R27	0811-2458	1	R: fxd prec ww 3000 ohms 0.01%	-hp-	
R28, R29	0811-1126	1	Resistor set: matched ww 2000 ohms 0.001% 3000 ohms 0.01%	-hp-	
	00745-01102	1	Heat sink	-hp-	
	0340-0140	2	Insulator: TSTR	86684	DF31A Rev. A
A1A2	**00745-66942**		**Oven Ass'y (Includes A1A2A1 PC Ass'y: Reference Regulator)**	**-hp-**	
	0410-0127	1	Oven: component	-hp-	
A1A2A1	00745-66545	1	PC Ass'y: Reference Regulator (parts not separately replaceable)	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
1A2 (Cont'd)						
R1	1902-0544	1	Diode: breakdown 6.5 V 5% 7.5 A 400 mW	03877	PR6410	
R2, CR3	1901-0040	67	Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
1, Q2	1854-0033		TSTR: Si NPN 2N3391 aged	07263	S3620	
3	1854-0221	13	TSTR: Si NPN dual	28287	BD-1148	
4	1853-0083	1	TSTR: Si PNP dual	07263	SP 12102	
5	1854-0221		TSTR: Si NPN dual	28287	BD-1148	
1	0698-3359	7	R: fxd met flm 12.7 kilohms 1% 1/8 W	14674	C4	obd
2	0757-0446		R: fxd met flm 15 kilohms 1% 1/8 W	75042	CEA T-O	obd
3	0698-3359		R: fxd met flm 12.7 kilohms 1% 1/8 W	14674	C4	obd
4			Not assigned			
5, R6	0757-0434	7	R: fxd met flm 3650 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
7	0698-3495	1	R: fxd met flm 866 ohms 1% 1/8 W	14674	C4 T-O	obd
8*	0698-4086	1	R: fxd met flm 22.8 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
9*	0757-0277	4	R: fxd met flm 49.9 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
10*	0757-0398	1	R: fxd met flm 75 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
11	0698-4474	1	R: fxd met flm 8450 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
12	0757-0462		R: fxd met flm 27.4 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
13	0698-4505		R: fxd met flm 71.5 kilohms 1% 1/8 W	14674	C4 T-O	obd
1A3	**00745-66543**		**PC Ass'y: 19.8 V Generator**	-hp-		
1	0180-0387	4	C: fxd Ta elect 47 uF 5% 20 vdcw	56289	150D476X5020R2-DYS	
2	0180-0116	5	C: fxd Ta elect 6.8 uF 10% 35 vdcw	56289	150D685X9035B2-DYS	
3	0140-0207	5	C: fxd mica 330 pF 5% 500 vdcw	72136	RDM15F331J5C	
4	0140-0176	3	C: fxd mica 100 pF 2% 300 vdcw	72136	RDM15F101G3C	
5	0180-0387		C: fxd Ta elect 47 uF 5% 20 vdcw	56289	150D476X5020R2-DYS	
6	0140-0207		C: fxd mica 330 pF 5% 500 vdcw	72136	RDM15F331J5C	
7	0180-0116		C: fxd Ta elect 6.8 uF 10% 35 vdcw	56289	150D685X9035B2-DYS	
8	0140-0176		C: fxd mica 100 pF 2% 300 vdcw	72136	RDM15F101G3C	
Q1	1853-0001	2	TSTR: Si PNP	01295	SM 1016B	
Q2 thru Q4	1854-0033		TSTR: Si NPN 2N3391	07263	S3620	
Q5	1854-0215	40	TSTR: Si NPN 2N3904	04713	SPS-3611	
Q6	1850-0111	1	TSTR: Ge PNP 2N404A	01295	2N404A	
Q7	1854-0039	3	TSTR: Si NPN 2N3053	04713	2N3053	
Q8 thru Q10	1853-0010	3	TSTR: Si PNP	04713	SM4713	
Q11	1853-0036	24	TSTR: Si PNP 2N3906	04713	SPS-3612	
Q12	1851-0017	2	TSTR: Ge NPN 2N1304	01295	2N1304	
R1	0686-1015	4	R: fxd comp 100 ohms 5% 1/2 W	01121	EB 1015	
R2	0757-0401	10	R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O	obd
R3	0698-3450	2	R: fxd met flm 42.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R4	0757-0467		R: fxd met flm 121 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R5	0757-0444	2	R: fxd met flm 12.1 kilohms 1% 1/8 W	14674	C4 T-O	obd
R6	0757-0273	4	R: fxd met flm 3010 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R7	0757-0444		R: fxd met flm 12.1 kilohms 1% 1/8 W	14674	C4 T-O	obd
R8	0811-2491	1	R: fxd prec ww 2460 ohms 0.02% 1/16 W	-hp-		
R9	2100-1753	2	R: var ww lin 20 ohms 5% 1 W	75042	CT-106-4	obd
R10	0698-4445	4	R: fxd met flm 5760 ohms 1% 1/8 W	14674	C4 T-O	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A1A3 (Cont'd)						
R11	0698-3153	1	R: fxd met flm 3830 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R12	0757-0443	2	R: fxd met flm 11 kilohms 1% 1/8 W	75042	CEA T-O	obd
R13	0811-1125	1	Resistor set: matched ww 7500 ohms 0.02%, 4925 ohms 0.02% (includes A1A3R17)	-hp-		
R14	2100-2350	2	R: var prec ww 50 ohms 10% 1/2 W	-hp-		
R15	0811-2467	2	R: fxd ww 0.51 ohms 5% 1/2 W	75042	BW-20	
R16	2100-1752	2	R: fxd ww lin 10 ohms 5% 1 W	75042	CT-106-4	obd
R17	0811-1125		Resistor set: matched ww 7500 ohms 0.02%, 4925 ohms 0.02% (includes A1A3R13)	-hp-		
R18	0686-1015		R: fxd comp 100 ohms 5% 1/2 W	01121	EB 1015	
R19	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O	obd
R20	0698-3450		R: fxd met flm 42.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R21			Not assigned			
R22	0698-4504	1	R: fxd met flm 69.8 kilohms 1% 1/8 W	14674	C4 T-O	obd
R23	0698-4470		R: fxd met flm 6980 ohms 1% 1/8 W	75042	CEA T-O	obd
R24	0698-4473	3	R: fxd met flm 8060 ohms 1% 1/8 W	14674	C4 T-O	obd
R25	0698-4495	1	R: fxd met flm 37.4 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R26	2100-1753		R: var ww lin 20 ohms 5% 1 W	75042	CT-106-4	obd
R27	0811-2492	1	R: fxd prec ww 756 ohms 0.1% 1/8 W	-hp-		
R28	0698-3493	1	R: fxd met flm 4120 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R29	0698-4445		R: fxd met flm 5760 ohms 1% 1/8 W	14674	C4 T-O	obd
R30	0757-0443		R: fxd met flm 11 kilohms 1% 1/8 W	75042	CEA T-O	obd
R31	0811-1124	1	Resistor set: matched ww 6000 ohms 0.02%, 3.875 ohms 0.02% (includes A1A3R35)	-hp-		
R32	2100-2350		R: var prec ww 50 ohms 10% 1/2 W	-hp-		
R33	0811-2467		R: fxd ww 0.51 ohms 5% 1/2 W	75042	BW-20	
R34	2100-1752		R: var ww lin 10 ohms 5% 1 W	75042	CT-106-4	obd
R35	0811-1124		Resistor set: matched ww 6000 ohms 0.02%, 3.875 ohms 0.02% (includes A1A3R31)	-hp-		
R36	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O	obd
A1A4	**00745-66544**		**PC Ass'y: Oven Control**	**-hp-**		
C1, C2	0180-0387		C: fxd Ta elect 47 uF 5% 20 vdcw	56289	150D476X5020R2-DYS	
C3	0180-2050	1	C: fxd Ta elect 0.082 uF 10% 35 vdcw	56289	150D823X9035A2-DYS	
C4 thru C6	0140-0198	6	C: fxd mica 200 pF 5% 300 vdcw	14655	RDM15F201J3C	
C7	0180-1819	2	C: fxd Al elect 100 uF +75% -10% 50 vdcw	56289	30D107G050DH2-DSM	
CR1, CR2	1901-0025	34	Diode: Si 100 piv 12 pF 100 mA	03877	SG-817	
CR3 thru CR5	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
K1, K2	0490-0486	40	Relay: reed	-hp-		
Q1	1853-0036		TSTR: Si PNP 2N3906 aged	04713	SPS-3612	
Q2	1853-0217	4	TSTR: Si PNP 310 mW 4 MHz	04713	MPS-404A	
Q3 thru Q5	1854-0215		TSTR: Si NPN 2N3904 aged	04713	SPS-3611	
Q6	1854-0033		TSTR: Si NPN 2N3391 aged	07263	S3620	
Q7	1853-0001		TSTR: Si PNP	01295	SM 1016B	
Q8	1850-0098	1	TSTR: Ge PNP	04713	SPS-776	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
1A4 (Cont'd)					
1	0757-0732	1	R: fxd met flm 909 ohms 1% 1/4 W	14674	C5 T-O obd
2	0686-2025	3	R: fxd comp 2000 ohms 5% 1/2 W	01121	EB 2025
3	0686-2235	1	R: fxd comp 22 kilohms 5% 1/2 W	01121	EB 2235
4	0757-0340	1	R: fxd met flm 10.0 kilohms 1% 1/4 W	91637	MFF-1/8-32 T-1 obd
5	2100-1760	1	R: var ww lin 5000 ohms 5% 1 W	75042	CT-106-4 obd
6	0686-1025	1	R: fxd comp 1000 ohms 5% 1/2 W	01121	EB 1025
7	0686-2025		R: fxd comp 2000 ohms 5% 1/2 W	01121	EB 2025
8	0698-4482	2	R: fxd met flm 17.4 kilohms 1% 1/8 W	14674	C4 T-O obd
9	0698-4205	2	R: fxd met flm 21 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1 obd
10	0686-2025		R: fxd comp 2000 ohms 5% 1/2 W	01121	EB 2025
11			Not assigned		
12	0686-4325	2	R: fxd comp 4300 ohms 5% 1/2 W	01121	EB 4325
13	0698-4482		R: fxd met flm 17.4 kilohms 1% 1/8 W	14674	C4 T-O obd
14	0698-4205		R: fxd met flm 21 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1 obd
15	0686-4325		R: fxd comp 4300 ohms 5% 1/2 W	01121	EB 4325
16	0683-1015	2	R: fxd comp 100 ohms 5% 1/4 W	01121	CB 1015
17	0686-2035	1	R: fxd comp 20 kilohms 5% 1/2 W	01121	EB 2035
18	0686-1035	1	R: fxd comp 10 kilohms 5% 1/2 W	01121	EB 1035
19	0686-3325	1	R: fxd comp 3300 ohms 5% 1/2 W	01121	EB 3325
20	0686-2725	1	R: fxd comp 2700 ohms 5% 1/2 W	01121	EB 2725
21			Not assigned		
22	0686-1015		R: fxd comp 100 ohms 5% 1/2 W	01121	EB 1015
23, R24	0686-1005	2	R: fxd comp 10 ohms 5% 1/2 W	01121	EB 1005
25	0686-1015		R: fxd comp 100 ohms 5% 1/2 W	01121	EB 1015
26	0811-2463	2	R: fxd prec ww 1591 ohms 0.1% 1/8 W	-hp-	
27, R28	0811-2462	2	R: fxd prec ww 99 ohms 0.1% 1/8 W	-hp-	
29	0811-2463		R: fxd prec ww 1591 ohms 0.1% 1/8 W	-hp-	
30	0811-2461	1	R: fxd prec ww 12.68 ohms 0.5% 3/16 W	-hp-	
31			Not assigned		
32, R33	0811-2493	2	R: fxd prec ww 6.43 ohms 0.2% 1/8 W	-hp-	
1	3101-0829	1	Switch: slide DP3T	82389	XW-1209
	1200-0043	1	Insulator: TSTR mounting	13103	10598
	00745-01101	1	Heat sink: Al	-hp-	
2	**00745-66512**		**PC Ass'y: Error Amplifier**	**-hp-**	
1	0160-2018	2	C: fxd mica 250 pF 5% 500 vdcw	00853	RDM15F251J5S
2	0160-2201	2	C: fxd mica 51 pF 5% 300 vdcw	72136	RDM15E510J3C
3			Not assigned		
4, C5	0180-0354	4	C: fxd Ta elect 40 uF 5% 10 vdcw	56289	150D406X5010B2-DYS
6	0180-0116		C: fxd Ta elect 6.8 uF 10% 35 vdcw	56289	150D685X9035B2-DYS
7	0180-0354		C: fxd Ta elect 40 uF 5% 10 vdcw	56289	150D406X5010B2-DYS
8	0180-0155	3	C: fxd Ta elect 2.2 uF 20% 20 vdcw	56289	150D225X0020A2-DYS
9	0180-0354		C: fxd Ta elect 40 uF 5% 10 vdcw	56289	150D406X5010B2-DYS
10, C11	0180-2105	2	C: fxd Ta elect 5 uF 20% 35 vdcw	84411	HEW-104
12, C13	0180-0356	2	C: fxd Ta elect 70 uF 20% 15 vdcw	56289	109D706C2015F2-DYP
14, C15	0180-0155		C: fxd Ta elect 2.2 uF 20% 20 vdcw	56289	150D225X0020A2-DYS

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2 (Cont'd)					
CR1	1910-0014	1	Diode: Ge 1N277	03877	
CR2	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
CR3			Not assigned		
CR4	1902-3182		Diode: breakdown 12.1 V 5% 400 mW	04713	SZ10939-137
CR5	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
CR6	1901-3124	1	Diode: Si breakdown 6.98 V 5% 400 mW	04713	SZ10939-137
CR7	1902-3182		Diode: Si breakdown 12.1 V 5% 400 mW	04713	SZ10939-206
CR8	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
CR9 thru CR12	1901-0053	4	Diode: Si 30 piv 2 pF 30 mA 2 ns	07263	FD 3444
CR13	1902-3182		Diode: Si breakdown 12.1 V 5% 400 mW	04713	SZ10939-206
CR14	1901-0053		Diode: Si 30 piv 2 pF 30 mA 2 ns	07263	FD 3444
CR15	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
K1	0490-0486		Relay: reed	hp-	
L1	9100-1611	1	Coil: molded choke 0.22 uH 20%	52142	15-4415-2M
Q1	1854-0221		TSTR: Si NPN dual	05397	BD-1148
Q2, Q3	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612
Q4 thru Q6	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611
Q7	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612
Q8, Q9	1854-0221		TSTR: Si NPN dual	05397	BD-1148
Q10 thru Q12	1854-0071	21	TSTR: Si NPN 2N3391	01295	SKA1124
Q13	1854-0221		TSTR: Si NPN dual aged	05397	BD-1148
Q14 thru Q16	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
Q17	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612
Q18	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611
Q19	1855-0006	3	TSTR: Si FET P-channel	17856	SU 414A
Q20, Q21	1855-0046	2	TSTR: Si FET N-channel	01295	SFB 1252
Q22	1855-0006		TSTR: Si FET P-channel	17856	SU 414A
Q23, Q24	1854-0221		TSTR: Si NPN dual	05397	BD-1148
Q25, Q26	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
Q27	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612
Q28	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
R1	0757-0161	3	R: fxd met flm 604 ohms 1% 1/8 W	14674	C4 T-O obd
R2	0757-0449		R: fxd met flm 20 kilohms 1% 1/8 W	14674	C4 T-O obd
R3, R4	0698-3262	3	R: fxd met flm 40.2 ohms 1% 1/8 W	14674	C4 T-O obd
R5	0757-0449		R: fxd met flm 20 kilohms 1% 1/8 W	14674	C4 T-O obd
R6	0757-0427	2	R: fxd met flm 1500 ohms 1% 1/8 W	91637	MF-1/10-32 T-1 obd
R7, R8	0757-0284	16	R: fxd met flm 150 ohms 1% 1/8 W	75042	CEA T-O obd
R9	2100-1754	2	R: var ww lin 50 ohms 10% 1/2 W	75042	CT-106-4 obd
R10	0757-0455	3	R: fxd met flm 36.5 kilohms 1% 1/8 W	75042	CEA T-O obd
R11	0757-0407		R: fxd met flm 200 ohms 1% 1/8 W	14674	C4 T-O obd
R12	0698-3558	3	R: fxd met flm 4020 ohms 1% 1/8 W	14674	C4 T-O obd
R13	0757-0407		R: fxd met flm 200 ohms 1% 1/8 W	14674	C4 T-O obd
R14	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O obd
R15	0757-0273		R: fxd met flm 3010 ohms 1% 1/8 W	91637	MF-1/10-32 T-1 obd
R16	0757-0283	7	R: fxd met flm 2000 ohms 1% 1/8 W	14674	C4 T-O obd
R17			Not assigned		
R18	0757-0161		R: fxd met flm 604 ohms 1% 1/8 W	14674	C4 T-O obd
R19	0757-0283		R: fxd met flm 2000 ohms 1% 1/8 W	14674	C4 T-O obd
R20	0757-0161		R: fxd met flm 604 ohms 1% 1/8 W	14674	C4 T-O obd
R21*	0757-0407		R: fxd met flm 200 ohms 1% 1/8 W	14674	C4 T-O obd
R22	0698-3262		R: fxd met flm 40.2 ohms 1% 1/8 W	14674	C4 T-O obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR	MFR. PART NO
A2 (Cont'd)					
R23	0757-0346	2	R: fxd met flm 10 ohms 1% 1/8 W	75042	CEA T-O
R24	0684-1021	68	R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
R25	0684-1031	11	R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031
R26	0757-0455		R: fxd met flm 36.5 kilohms 1% 1/8 W	75042	CEA T-O
R27	0757-0281	4	R: fxd met flm 2740 ohms 1% 1/8 W	75042	CEA T-O
R28, R29	0757-0438	6	R: fxd met flm 5110 ohms 1% 1/8 W	14674	C4 T-O
R30	0757-0281		R: fxd met flm 2740 ohms 1% 1/8 W	75042	CEA T-O
R31			Not assigned		
R32, R33	0698-4421	6	R: fxd met flm 249 ohms 1% 1/8 W	91637	MF-1/10-32 T-1
R34	2100-1757	3	R: var ww lin 500 ohms 10% 1/2 W	75042	CT-106-4
R35	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031
R36	0757-0455		R: fxd met flm 36.5 kilohms 1% 1/8 W	75042	CEA T-O
R37	0757-0448	6	R: fxd met flm 18.2 kilohms 1% 1/8 W	75042	CEA T-O
R38	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
R39	0684-1051	4	R: fxd comp 1 megohm 10% 1/4 W	01121	CB 1051
R40	0684-3931	1	R: fxd comp 39 kilohms 10% 1/4 W	01121	CB 3931
R41			Not assigned		
R42	0698-3518	1	R: fxd met flm 7320 ohms 1% 1/8 W	75042	CEA T-O
R43, R44	0684-3331	4	R: fxd comp 33 kilohms 10% 1/4 W	01121	CB 3331
R45	0698-3548	1	R: fxd met flm 732 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R46	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O
R47	0684-1051		R: fxd comp 1 megohm 10% 1/4 W	01121	CB 1051
R48, R49	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O
R50	0757-0453		R: fxd met flm 30.1 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R51	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O
R52	0757-0288	1	R: fxd met flm 9090 ohms 1% 1/8 W	14674	C4 T-O
R53	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O
R54	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031
R55	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O
R56	0698-5099	2	R: fxd comp 3.9 megohms 10% 1/4 W	01121	CB 3951
R57, R58	0684-1051		R: fxd comp 1 megohm 10% 1/4 W	01121	CB 1051
R59	0698-5099		R: fxd comp 3.9 megohms 10% 1/4 W	01121	CB 3951
R60	0757-0465	1	R: fxd met flm 100 kilohms 1% 1/4 W	14674	C4 T-O
R61	0684-1041	6	R: fxd comp 100 kilohms 10% 1/4 W	01121	CB 1041
R62	0683-5135	1	R: fxd comp 51 kilohms 5% 1/4 W	01121	CB 5135
R63	0684-1041		R: fxd comp 100 kilohms 10% 1/4 W	01121	CB 1041
R64, R65	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
R66	0684-1041		R: fxd comp 100 kilohms 10% 1/4 W	01121	CB 1041
R67	2100-1757		R: var ww lin 500 ohms 10% 1/2 W	75042	CT-106-4
R68	0684-1041		R: fxd comp 100 kilohms 10% 1/4 W	01121	CB 1041
R69	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031
R70	0684-2231		R: fxd comp 22 kilohms 10% 1/4 W	01121	CB 2231
R71			Not assigned		
R72	0684-1041		R: fxd comp 100 kilohms 10% 1/4 W	01121	CB 1041
R73	0684-3331		R: fxd comp 33 kilohms 10% 1/4 W	01121	CB 3331
R74, R75	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
T1	0853-0009	1	Thermocouple ass'y	-hp-	
A3	**00745-66513**		**PC Ass'y: Sampling Amplifier**	**-hp-**	
A1, A2	1810-0012	2	Resistor network: 8 fxd resistors	56289	118C67

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A3 (Cont'd)						
C1			Not assigned			
C2 thru C4	0140-0206	6	C: fxd mica 270 pF 5% 500 vdcw	00853	RDM15F271J5C	
C5, C6	0180-0355	2	C: fxd Ta elect 3.4 uF 20% 35 vdcw	56289	151D345X0035X2-DYS	
C7, C8	0140-0206		C: fxd mica 270 pF 5% 500 vdcw	00853	RDM15F271J5C	
C9	0160-0991	1	C: fxd mica 500 pF 5%	72136	RDM19F501J3C	
C10			Not assigned			
C11	0140-0175	1	C: fxd mica 39 pF 2% 300 vdcw	00853	RDM15E390G3C	
C12	0121-0036	10	C: var cer 5.5 - 18 pF	72982	538-006 C0P0 92R	
C13	0160-0763	2	C: fxd mica 5 pF 10% 500 vdcw	00853	RDM15C050K5S	
C14	0150-0029	1	C: fxd TiO_2 1 pF 10% 500 vdcw	78488	Type GA	
C15	0180-0291	2	C: fxd Ta elect 1.0 uF 10% 35 vdcw	56289	150D105X9035A2-DYS	
CR1 thru CR12	1901-0040		Diode: Si 30 piv 2 pF 30 mA	03877	SG9142	
K1	0490-0486		Relay: reed	-hp-		
Q1	1854-0221		TSTR: Si NPN dual	05397	BD-1148	
Q2	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612	
Q3	1853-0217		TSTR: Si PNP	04713	MPS-404A	
Q4, Q5	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q6	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
Q7, Q8	1853-0217		TSTR: Si PNP	04713	MPS-404A	
Q9, Q10	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
Q11	1855-0006		TSTR: Si FET P-channel	17856	SU414A	
Q12	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q13	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612	
Q14	1855-0040	3	TSTR: Si FET N-channel 2N3819 *	01295		obd
Q15	1855-0036	1	TSTR: FET dual	17856	DN577	
Q16	1854-0221		TSTR: Si NPN dual	05397	BD-1148	
Q17, Q18	1853-0089	9	TSTR: Si PNP 2N4917	07263	2N4917	
Q19, Q20	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q21, Q22	1854-0337	4	TSTR: Si NPN	04713	SM1570-2	
Q23	1853-0009	1	TSTR: Si PNP	04713	SS2111	
R1	0757-0448		R: fxd met flm 18.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R2*	0698-4487	4	R: fxd met flm 25.5 kilohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R3	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	obd
R4	0757-0438		R: fxd met flm 5110 ohms 1% 1/8 W	14674	C4 T-O	obd
R5	0757-0433	11	R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O	obd
R6	0757-0421	3	R: fxd met flm 825 ohms 1% 1/8 W	75042	CEA T-O	obd
R7	0757-0430	7	R: fxd comp 2210 ohms 1% 1/8 W	14674	C4 T-O	obd
R8	0698-4494	1	R: fxd met flm 35.7 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R9	0698-4498	1	R: fxd met flm 53.6 kilohms 1% 1/8 W	14674	C4 T-O	obd
R10	2100-1761	1	R: var ww lin 10 kilohms 10% 1/2 W	75042	CT-106-4	obd
R11	0683-2045	1	R: fxd comp 200 kilohms 5% 1/4 W	01121	CB 2045	
R12	0698-4497	1	R: fxd met flm 48.7 kilohms 1% 1/8 W	14674	C4 T-O	obd
R13, R14	0684-8221	2	R: fxd comp 8200 ohms 10% 1/4 W	01121	CB 8221	
R15	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031	
R16 thru R19	0684-2231	5	R: fxd comp 22 kilohms 10% 1/4 W	01121	CB 2231	
R20	0698-4487		R: fxd met flm 25.5 kilohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R21			Not assigned			
R22	0757-0410	1	R: fxd met flm 301 ohms 1% 1/8 W	75042	CEA T-O	obd
R23	0757-0438		R: fxd met flm 5110 ohms 1% 1/8 W	14674	C4 T-O	obd
R24	0757-0407		R: fxd met flm 200 ohms 1% 1/8 W	75042	CEA T-O	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
3 (Cont'd)					
25	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O obd
26	0757-0283		R: fxd met flm 2000 ohms 1% 1/8 W	14674	C4 T-O obd
27	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O obd
28	0698-3558		R: fxd met flm 4020 ohms 1% 1/8 W	14674	C4 T-O obd
29	0757-0438		R: fxd met flm 5110 ohms 1% 1/8 W	14674	C4 T-O obd
30, R31			Not assigned		
32	0757-0407		R: fxd met flm 200 ohms 1% 1/8 W	14674	C4 T-O obd
33	0698-4487		R: fxd met flm 25.5 kilohms 1% 1/8 W	91637	MF-1/10-32 T-1 obd
34	2100-1754		R: var ww lin 50 ohms 10% 1/2 W	75042	CT-106-4 obd
35	0757-0283		R: fxd met flm 2000 ohms 1% 1/8 W	14674	C4 T-O obd
36	0757-0435	3	R: fxd met flm 3920 ohms 1% 1/8 W	14674	C4 T-O obd
37	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
38	0757-0413	1	R: fxd met flm 392 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1 obd
39	0757-0407		R: fxd met flm 200 ohms 1% 1/8 W	14674	C4 T-O obd
40	0757-0416	3	R: fxd met flm 511 ohms 1% 1/8 W	14674	C4 T-O obd
41			Not assigned		
42	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O obd
43	0684-1011	3	R: fxd comp 100 ohms 10% 1/4 W	01121	CB 1011
44, R45	0684-1001	3	R: fxd comp 10 ohms 10% 1/4 W	01121	CB 1001
46	0684-1011		R: fxd comp 100 ohms 10% 1/4 W	01121	CB 1011
47	0757-0284		R: fxd met flm 150 ohms 1% 1/8 W	75042	CEA T-O obd
48	0757-0438		R: fxd met flm 5110 ohms 1% 1/8 W	14674	C4 T-O obd
49	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O obd
50	0757-0416		R: fxd met flm 511 ohms 1% 1/8 W	14674	C4 T-O obd
51	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O obd
1	**00745-66514**		**PC Ass'y: Preamplifier**	**-hp-**	
	0160-0207	1	C: fxd my 0.01 uF 5% 200 vdcw	56289	192P10352-PTS
	0140-0204	2	C: fxd mica 47 pF 5% 500 vdcw	72136	RDM15E470J5C
	0180-0309	4	C: fxd Ta elect 4.7 uF 20% 10 vdcw	90201	TAS475M010P1A
, C5	0160-0179	2	C: fxd mica 33 pF 5% 300 vdcw	72136	RDM15E330J3S
	0140-0205	1	C: fxd mica 62 pF 5% 300 vdcw	14655	RDM15E620J3C
	0160-2198	2	C: fxd mica 20 pF 5% 300 vdcw	14655	RDM15C200J3C
	0180-0139	1	C: fxd Al elect 200 uF +100% -10% 3 vdcw	56289	D36547-DSB
	0180-0062	1	C: fxd Al elect 300 uF +100% -10% 6 vdcw	56289	30D307G006DF2-DSM
0	0160-0939	1	C: fxd mica 430 pF 5% 300 vdcw	00853	RDM15F431J3C
1	0160-0155	1	C: fxd my 0.0033 uF 10% 200 vdcw	56289	192P33292-PTS
2	0150-0093	10	C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA obd
1	1902-3086	3	Diode: Si breakdown 4.75 V 2%	04713	SZ10939-90
2	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
3, CR4	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
thru K4	0490-0486		Relay: reed	-hp-	
	9100-1401	1	Coil: fxd R.F. choke 30 uH (Includes R50)	-hp-	
	9100-1402	1	Coil: fxd R.F. choke 3.3 uH (Includes R52)	-hp-	
	9100-1624	1	Coil: molded choke 30 uH 5%	82142	15-4465-1J

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR	MFR. PART NO.
A4 (Cont'd)					
L4	9100-1403	1	Coil: fxd R.F. choke 22 uH (Includes R40)	-hp-	
L5	9140-0047	1	Coil: fxd R.F. 20 uH 10% 2.5 mHz	82142	15U-200K
L6	9100-1627	1	Coil: molded choke 39 uH 5%	82142	15-1315-2J
Q1	1855-0040		TSTR: Si FET N-channel 2N3819	07263	
Q2, Q3	1854-0221	2	TSTR: Si NPN dual	04713	8D-1148
Q4	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3811
Q5 thru Q8	1853-0085		TSTR: Si PNP 2N4917	07263	2N4917
Q9	1853-0037	1	TSTR: Si PNP	04713	SS-2109 Rev. B
Q10	1854-0337		TSTR: Si NPN	04713	SM1870-2
R1	0757-0283		R: fxd met flm 2000 ohms 1% 1/8 W	14674	C4 T-O
R2	0757-0282	4	R: fxd met flm 221 ohms 1% 1/8 W	14674	C4 T-O
R3	0698-4514	2	R: fxd met flm 105 kilohms 1% 1/8 W	14674	C4 T-O
R4	0698-4356	2	R: fxd met flm 59 ohms 1% 1/8 W	14674	C4 T-O
R5	0698-3279		R: fxd met flm 4990 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R6	0757-0415	3	R: fxd met flm 475 ohms 1% 1/8 W	91637	MF-1/10-32 T-1
R7	0698-4438	2	R: fxd met flm 3090 ohms 1% 1/8 W	14674	C4 T-O
R8	2100-2413	1	R: var lin 200 ohms 10% 1/2 W	73138	62-2[illegible]-1
R9	0698-4397	1	R: fxd met flm 84.5 ohms 1% 1/8 W	14674	C4 T-O
R10	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O
R11	0757-0437	6	R: fxd met flm 4750 ohms 1% 1/8 W	14674	C4 T-O
R12	0698-4386		R: fxd met flm 59 ohms 1% 1/8 W	14674	C4 T-O
R13	0757-0282		R: fxd met flm 221 ohms 1% 1/8 W	14674	C4 T-O
R14	0698-4514		R: fxd met flm 105 kilohms 1% 1/8 W	14674	C4 T-O
R15	0698-4415	1	R: fxd met flm 165 ohms 1% 1/8 W	75042	CEA T-O
R16	0757-0430		R: fxd met flm 2210 ohms 1% 1/8 W	14674	C4 T-O
R17	0757-0284		R: fxd met flm 150 ohms 1% 1/8 W	75042	CEA T-O
R18, R19	0757-0385	6	R: fxd met flm 22.1 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R20	0757-0278	1	R: fxd met flm 1780 ohms 1% 1/8 W	75042	CEA T-O
R21	0757-0437		R: fxd met flm 4750 ohms 1% 1/8 W	14674	C4 T-O
R22	0757-0284		R: fxd met flm 150 ohms 1% 1/8 W	75042	CEA T-O
R23	0757-0430		R: fxd met flm 2210 ohms 1% 1/8 W	14674	C4 T-O
R24	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O
R25	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O
R26	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O
R27	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O
R28	0698-4474		R: fxd met flm 8450 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R29	0757-0406	15	R: fxd met flm 182 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R30	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O
R31			Not assigned		
R32	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O
R33	0757-0408	1	R: fxd met flm 243 ohms 1% 1/8 W	75042	CEA T-O
R34	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O
R35	0683-3955	1	R: fxd comp 3.9 megohms 5% 1/4 W	01121	CB 3955
R36	0698-4489	2	R: fxd met flm 28 kilohms 1% 1/8 W	14674	C4 T-O
R37	0698-3226	1	R: fxd met flm 6490 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R38	0698-3497		R: fxd met flm 6040 ohms 1% 1/8 W	75042	CEA T-O
R39	2100-1758	3	R: var lin ww 1000 ohms 10% 1 W	75042	CT-106-4
R40	9100-1403		Coil: fxd R.F. choke 22 uH (Includes R40)	-hp-	
R41			Not assigned		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
(Cont'd)						
2	0698-4123		R: fxd met flm 499 ohms 1% 1/8 W	14674	C4 T-O	obd
3	0757-0389	1	R: fxd met flm 33.2 ohms 1% 1/8 W	75042	CEA T-O	obd
4, R45	0698-4479	2	R: fxd met flm 14 kilohms 1% 1/8 W	14674	C4 T-O	obd
6	0757-0434		R: fxd met flm 3650 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
7	0757-0381	1	R: fxd met flm 15 ohms 1% 1/8 W	75042	CEA T-O	obd
8	0698-4489		R: fxd met flm 28 kilohms 1% 1/8 W	14674	C4 T-O	obd
9	0757-0283		R: fxd met flm 2000 ohms 1% 1/8 W	14674	C4 T-O	obd
0	9100-1401		Coil: fxd R.F. choke 30 uH (Includes R50)	-hp-		
1			Not assigned			
2	9100-1422		Coil: fxd R.F. choke 3.3 uH (Includes R52)	-hp-		
3	0757-0991	3	R: fxd met flm 20 ohms 1% 1/2 W	91637	MFF-1/2-10 T-1	obd
	1205-0018	2	Heat sink: semiconductor (Q10)	05820	NF-203	
	1205-0090	2	Heat sink: semiconductor (Q5-Q8)	13103	3118B	
5	**00745-66515**		**PC Ass'y: Power Amplifier**	-hp-		
	0140-0216	2	C: fxd mica 120 pF 2% 300 vdcw	14655	RDM15F121G3C	
, C3	0180-0367	2	C: fxd Al elect 20 uF +75% -10% 200 vdcw	56289	34D206F200FJ4-DSB	
	0160-2207	1	C: fxd mica 300 pF 5% 500 vdcw	00853	RDM15F301J3C	
	0140-0156	3	C: fxd mica 1500 pF 2% 300 vdcw	72136	RDM19F152G3C	
	0140-0206		C: fxd mica 270 pF 5% 500 vdcw	00853	RDM15F271J5C	
	0140-0216		C: fxd mica 120 pF 2% 300 vdcw	14655	RDM15F121G3C	
	0180-0116		C: fxd Ta elect 6.8 uF 10% 35 vdcw	56289	150D685X9035B2-DYS	
	0160-0170	3	C: fxd cer 0.22 uF +80% -20% 25 vdcw	56289	5C9B-CML	
11	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
12	1902-3139	2	Diode: breakdown Si 8.25 V 5%	04713	SZ10939-158	
13, CR4	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
15, CR6	1902-3105	2	Diode: breakdown Si 5.62 V 2%	04713	SZ 10939-111	
17, CR8	1902-3086		Diode: breakdown Si 4.75 V 2%	04713	SZ 10939-90	
	9100-1618	1	Coil: molded choke 5.6 uH 10%	82142	15-4435-1K	
, Q2	1854-0232	4	TSTR: Si NPN	86684	40327	
	1853-0089		TSTR: Si PNP 2N4917	07263	2N4917	
	1854-0215		TSTR: Si NPN 2N3904 aged	04713	SPS-3611	
, Q6	1854-0053	2	TSTR: Si NPN 2N2218	04713	2N2218	
, Q8	1853-0012	4	TSTR: Si PNP 2N2904A	04713	2N2904A	
0, Q10	1853-0038	7	TSTR: Si PNP	04713	SS-2123 Rev. B	
1	1854-0071		TSTR: Si NPN aged	01295	SKA1124	
2	1853-0036		TSTR: Si PNP 2N3906 aged	04713	SPS-3612	
, R2	0764-0003	2	R: fxd met ox 3300 ohms 5% 2 W	75042	RG-42	
	0757-0277		R: fxd met flm 49.9 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
	0698-6214	1	R: fxd comp 2200 ohms 5% 3 W	01121	GM 2225	
	0757-0406		R: fxd met flm 182 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
	0757-0446		R: fxd met flm 15 kilohms 1% 1/8 W	75042	CEA T-O	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A5 (Cont'd)						
R7	0698-4447	2	R: fxd met flm 280 ohms 1% 1/8 W	75042	CEA T-O	ob
R8	0757-0765	4	R: fxd met flm 36.5 kilohms 1% 1/4 W	14674	C5 T-O	ob
R9	0757-0416		R: fxd met flm 511 ohms 1% 1/8 W	14674	C4 T-O	ob
R10	0698-3440	1	R: fxd met flm 196 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	ob
R11	0757-0765		R: fxd met flm 36.5 kilohms 1% 1/4 W	14674	C5 T-O	ob
R12, R13	0757-0412	2	R: fxd met flm 365 ohms 1% 1/8 W	14674	C4 T-O	ob
R14, R15	0757-0277		R: fxd met flm 49.9 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	ob
R16 thru R19	0683-0275	4	R: fxd comp 2.7 ohms 5% 1/4 W	01121	CB 27G5	
R20, R21	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	ob
R22	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O	ob
R23	0757-0284		R: fxd met flm 150 ohms 1% 1/8 W	75042	CEA T-O	ob
R24	0757-0406		R: fxd met flm 182 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	ob
R25	0757-0346		R: fxd met flm 10 ohms 1% 1/8 W	75042	CEA T-O	ob
R26	0757-0391	1	R: fxd met flm 39.2 ohms 1% 1/8 W	14674	C4 T-O	ob
R27	0757-0411	4	R: fxd met flm 332 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	ob
R28	0757-0284		R: fxd met flm 150 ohms 1% 1/8 W	75042	CEA T-O	ob
R29	0698-4473		R: fxd met flm 8060 ohms 1% 1/8 W	14674	C4 T-O	ob
R30	0757-0765		R: fxd met flm 36.5 kilohms 1% 1/4 W	14674	C5 T-O	ob
R31	0698-4473		R: fxd met flm 8060 ohms 1% 1/8 W	14674	C4 T-O	ob
R32	0757-0765		R: fxd met flm 36.5 kilohms 1% 1/4 W	14674	C5 T-O	ob
R33	0698-3497	2	R: fxd met flm 6040 ohms 1% 1/8 W	75042	CEA T-O	ob
R34	0757-0450	11	R: fxd met flm 22.1 kilohms 1% 1/8 W	75042	CEA T-O	ob
R35	0698-5102	1	R: fxd comp 1.2 megohms 10% 1/4 W	01121	CB 1251	
R36, R37	0757-0440	3	R: fxd met flm 7500 ohms 1% 1/8 W	75042	CEA T-O	ob
	1205-0033	10	Heat sink: semiconductor (Q5-Q8)	05820	NF-207	
	1205-0087	4	Heat sink: TSTR (Q2, Q10, Q1, Q9)	13103	1103A	
A6	**00745-66516**		**PC Ass'y: High Frequency Switching**	**-hp-**		
A1, A2	1820-0067	4	Diode: integrated circuit	18324	SP631A	
C1*	0140-0178	3	C: fxd mica 560 pF 2% 300 vdcw	72136	RDM15F561G3C	
C2*, C3	0140-0207		C: fxd mica 330 pF 5% 500 vdcw	72136	RDM15F331J5C	
CR1 thru CR3	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
CR4 thru CR12	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817	
K1 thru K12	0490-0486		Relay: reed	-hp-		
Q1 thru Q15	1853-0016	45	TSTR: Si PNP 2N3638 aged	04713	SPS-3320	
R1 thru R9	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R10 thru R12	0684-4711	7	R: fxd comp 470 ohms 10% 1/4 W	01121	CB 4711	
R13, R14	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R15	0684-4711		R: fxd comp 470 ohms 1% 1/4 W	01121	CB 4711	
R16	2100-1756	1	R: var ww lin 200 ohms 10% 1/2 W	75042	CT-106-4	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
7	**00745-66517**		**PC Ass'y: Low Frequency Switching**	**-hp-**	
1, A2	1820-0067		Diode: integrated circuit	18324	SP631A
R1 thru CR7	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
1 thru K15	0490-0486		Relay: reed	-hp-	
1 thru Q14	1853-0016		TSTR: Si PNP 2N3638 aged	04713	SPS-3320
1 thru R12	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
13, R14	0684-4711		R: fxd comp 470 ohms 10% 1/4 W	01121	CB 4711
15	0757-0344	1	R: fxd met flm 1 megohm 1% 1/4 W	14674	C4 T-O obd
8	**00745-66518**		**PC Ass'y: Regulator**	**-hp-**	
1	0150-0093		C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA obd
2	0180-0104	1	C: fxd Al elect 200 uF +75% -10% 15 vdcw	56289	30D207G015DF2-DSM
3	0150-0093		C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA obd
4	0180-0116		C: fxd Ta elect 6.8 uF 10% 35 vdcw	56289	150D685X9035B2-DYS
5	0180-1819		C: fxd Al elect 100 uF +75% -10% 50 vdcw	56289	30D107G050DH2-DSM
6	0150-0086	2	C: fxd cer 4700 pF 20% 500 vdcw	56289	29C333
7	0180-0106	2	C: fxd Ta elect 60 uF 20% 6 vdcw	56289	150D606X0006B2-DYS
8	0150-0086		C: fxd cer 4700 pF 20% 500 vdcw	56289	29C333
9	0180-0106		C: fxd Ta elect 60 uF 20% 6 vdcw	56289	150D606X0006B2-DYS
R1, CR2	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
R3	1901-0200	4	Diode: Si 100 piv 3 A 1N4998	04713	SR1846-9
R4, CR5	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
R6	1902-3150	1	Diode: Si breakdown 9.09 V 2% 400 mW	04713	SZ 10939-171
R7	1901-0200		Diode: Si 100 piv 3 A 1N4998	04713	SR1846-9
R8	1902-3125	1	Diode: Si breakdown 6.98 V 2% 400 mW	04713	SZ 10939-138
R9, CR10	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
R11	1901-0158		Diode: Si 200 piv 0.75 A	04713	SR1358-3
R12	1902-3346	2	Diode: Si breakdown 51.1 V 2% 400 mW	04713	SZ10939-387
R13, CR14	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
R15	1901-0158		Diode: Si 200 piv 0.75 A	04713	SR1358-3
R16	1902-3346		Diode: Si breakdown 51.1 V 2% 400 mW	04713	SZ 10939-387
R17 thru CR20	1901-0158		Diode: Si 200 piv 0.75 A	04713	SR1358-3
R21	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
R22, CR23	1901-0033	2	Diode: Si 180 piv 13 pF 100 mA	03877	SG3396
R24, CR25	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
1	1853-0012		TSTR: Si PNP 2N2904A	04713	2N2904A
2	1854-0039		TSTR: Si NPN 2N3053	04713	2N3053
3, Q4	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124
5	1853-0012		TSTR: Si PNP 2N2904A	04713	2N2904A
6	1854-0039		TSTR: Si NPN 2N3053	04713	2N3053

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A8 (Cont'd)						
Q7	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
Q8	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q9	1853-0038		TSTR: Si PNP	04713	SS-2123 Rev. B	
Q10	1854-0232		TSTR: Si NPN	86684	40327	
Q11	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q12	1854-0022	2	TSTR: Si NPN	07263	SG1294	
Q13	1853-0038		TSTR: Si PNP	04713	SS-2123 Rev. B	
Q14	1854-0232		TSTR: Si NPN	86684	40327	
Q15	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q16	1854-0022		TSTR: Si NPN	07263	SG1294	
R1	0757-0282		R: fxd met flm 221 ohms 1% 1/8 W	14674	C4 T-O	obd
R2	0684-6821	1	R: fxd comp 6800 ohms 10% 1/4 W	01121	CB 6821	
R3	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	obd
R4	0757-0200	4	R: fxd met flm 5620 ohms 1% 1/8 W	14674	C4 T-O	obd
R5	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O	obd
R6	2100-1758		R: var ww lin 1000 ohms 10% 1/2 W	75042	CT-106-4	obd
R7	0757-0450		R: fxd met flm 22.1 kilohms 1% 1/8 W	75042	CEA T-O	obd
R8	0757-0282		R: fxd met flm 221 ohms 1% 1/8 W	14674	C4 T-O	obd
R9	0684-4721		R: fxd comp 4700 ohms 10% 1/4 W	01121	CB 4721	
R10	0698-4463	4	R: fxd met flm 845 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R11	0757-0451	2	R: fxd met flm 24.3 kilohms 1% 1/8 W	75042	CEA T-O	obd
R12	0813-0029	1	R: fxd prec ww 1 ohms 3% 3 W	-hp-		
R13	0757-0448		R: fxd met flm 18.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R14	0698-4472	1	R: fxd met flm 7680 ohms 1% 1/8 W	14674	C4 T-O	obd
R15	0757-0411		R: fxd met flm 332 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R16	0757-0774	2	R: fxd met flm 82.5 kilohms 1% 1/4 W	91637	MFF-1/8-32 T-1	obd
R17	0757-0430		R: fxd met flm 2210 ohms 1% 1/8 W	14674	C4 T-O	obd
R18	0698-4533	2	R: fxd met flm 294 kilohms 1% 1/8 W	14674	C4 T-O	obd
R19	0811-1733	2	R: fxd prec ww 3 ohms 1% 1 W	91637	RS-1A	
R20	0757-0437		R: fxd met flm 4750 ohms 1% 1/8 W	14674	C4 T-O	obd
R21	0698-4715	2	R: fxd met flm 14 kilohms 1% 1/4 W	91637	MFF-1/8-32 T-1	obd
R22	0757-0411		R: fxd met flm 332 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R23	0757-0774		R: fxd met flm 82.5 kilohms 1% 1/8 W	91637	MFF-1/8-32 T-1	obd
R24	0757-0430		R: fxd met flm 2210 ohms 1% 1/8 W	14674	C4 T-O	obd
R25	0698-4533		R: fxd met flm 294 kilohms 1% 1/8 W	14674	C4 T-O	obd
R26	0811-1733		R: fxd prec ww 3 ohms 1% 1 W	91637	RS-1A	
R27	0757-0437		R: fxd met flm 4750 ohms 1% 1/8 W	14674	C4 T-O	obd
R28	0698-4715		R: fxd met flm 14 kilohms 1% 1/4 W	91637	MFF-1/8-32 T-1	obd
R29	2100-1758		R: var ww lin 1000 ohms 5% 1 W	75042	CT-106-4	obd
R30	2100-1759	2	R: var ww lin 2000 ohms 5% 1 W	75042	CT-106-4	obd
R31	0698-4445		R: fxd met flm 5760 ohms 1% 1/8 W	14674	C4 T-O	obd
R32	0757-0394	2	R: fxd met flm 51.1 ohms 1% 1/8 W	75042	CEA T-O	obd
R33	0757-0415		R: fxd met flm 475 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R34	2100-1759		R: var ww lin 2000 ohms 5% 1 W	75042	CT-106-4	obd
R35	0757-0415		R: fxd met flm 475 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R36	0698-4445		R: fxd met flm 5760 ohms 1% 1/8 W	14674	C4 T-O	obd
R37	0757-0394		R: fxd met flm 51.1 ohms 1% 1/8 W	75042	CEA T-O	obd
R38, R39	0684-2211	2	R: fxd comp 220 ohms 10% 1/4 W	01121	CB2211	
	1205-0033		Heat sink: semiconductor	05820	NF-207	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A9	**00745-66519**		**PC Ass'y: Rectifier**	**-hp-**		
A1, A2	1901-0364	2	Diode ass'y: Si 200 piv	04713	SDA10185-4	
A3, A4	1901-0363	2	Diode ass'y: Si 100 piv	04713	SDA10185-3	
C1, C2	0180-2081	2	C: fxd Al elect 350 uF +50% -10% 150 vdcw	56289	39D357F150-JP4-DSB	
C3	0180-2082	1	C: fxd Al elect 4000 uF +75% -10% 25 vdcw	56289	39D408G025JS4-DSB	
CR1, CR2	1901-0200		Diode: Si 100 piv 3 A 1N4998	04713	SR1846-9	
R1, R2	0687-4731	2	R: fxd comp 47 kilohms 10% 1/2 W	01121	EB 4731	
	1205-0033		Heat sink: semiconductor	05820	NF-207	
	1400-0040	4	Clip: capacitor	80033	E-50008-007	
A10	**00745-60430**		**Ass'y: Decade**	**-hp-**		
	1251-0132	1	Connector: test point black	28499	69022-1165	
	1251-0131	2	Connector: test point red	28499	69026-1165	
	1251-2039	1	Connector: test point	71279	3367-1-03	
	00745-61601	2	Cable: decade (includes P1, W1, W2)	-hp-		
R1	0684-1041		R: fxd comp 100 kilohms 10% 1/4 W	01121	CB 1041	
R2	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031	
R3	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R4	0684-1011		R: fxd comp 100 ohms 10% 1/4 W	01121	CB 1011	
R5 thru R13	0757-0284		R: fxd met flm 150 ohms 1% 1/8 W	75042	CEA T-O	obd
R14 thru R22	0683-1505	9	R: fxd comp 15 ohms 5% 1/4 W	01121	CB 1505	
R23 thru R34	0757-0406		R: fxd met flm 182 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R35 thru R44	0757-0390	10	R: fxd met flm 36.5 ohms 1% 1/8 W	14674	C4 T-O	obd
S1	3100-1741	1	Switch: rotary	-hp-		
S2	3100-1742	1	Switch: rotary	-hp-		
S3 thru S6	3100-1740	4	Switch: rotary	-hp-		
T1, T2	9100-1347	2	Inductor: divider medium voltage, stud mount	-hp-		
T3 thru T6	9100-1346	4	Inductor: divider low voltage, switch mount	-hp-		
W1	00745-27304	2	Cable: flex	-hp-		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A11	**00745-60320**		**Ass'y: Readout (Refer to Mechanical Parts List)**	-hp-	
A1	00745-66523	1	PC ass'y: lamp	-hp-	
DS1 thru DS13	2140-0246	26	Lamp: incandescent	24455	1739D
A12	**00745-65950**		**PC Ass'y: Oscillator (Mother Board)**	-hp-	
	00745-66559	1	PC Ass'y: Mother Board only	-hp-	
C1	0121-0117	1	C: var air 12.5 - 86.9 pF	77630	823085
C2	0121-0007	1	C: var air 3.6 - 26 pF	80486	CT2-0-25L
J1	1251-0131		Connector: test point red	28499	69026-1165
L1	9100-1404	1	Coil: var inductor 550 - 740 uH	-hp-	
XA12A1	1251-1962		Connector: pc 20 (2 x 10)	71785	252-10-30-330
XA12A2 thru XA12A8	1251-1558		Connector: pc 15 (1 x 15)	71785	252-15-30-350
A12A1	**00745-66551**		**PC Ass'y: VFO**	-hp-	
C1	0140-0215	2	C: fxd mica 80 pF 2% 300 vdcw	14655	RDM15E800G3C
C2	0160-0455	1	C: fxd cer 18 pF 2% 600 vdcw	71590	TCN-18
C3	0160-0128	6	C: fxd cer 2.2 uF 20% 25 vdcw	56289	5C15C2-CML
C4, C5	0160-0170		C: fxd cer 0.22 uF +80% -20% 25 vdcw	56289	5C9B-CML
C6	0180-1735	1	C: fxd Ta [illegible]set 0.22 uF 10% 35 vdcw	56289	150D224X9035A2-DYS
C7	0160-0170		C: fxd 0.22 uF +80% -20% 25 vdcw	56289	5C9B-CML
C8	0140-0193	2	C: fxd mica 82 pF 5% 300 vdcw	72136	RDM15E820J3C
C9, C10	0160-0170		C: fxd cer 0.22 uF +80% -20% 25 vdcw	56289	5C9B-CML
C11	0150-0093		C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA obd
C12, C13	0160-0170		C: fxd cer 0.22 uF +80% -20% 25 vdcw	56289	5C9B-CML
CR1	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
CR2	0122-0015	1	Diode: voltage variable 150 pF 10 wiv	04713	SMV411
CR3 thru CR8	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
K1 thru K3	0490-0486		Relay: reed	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A12A1 (Cont'd)						
Q1 thru Q3	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
Q4	1855-0057	2	TSTR: FET Si N-channel	04713	SS-3651	
Q5	1853-0089		TSTR: Si PNP 2N4917	07263	2N4917	
Q6	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
Q7	1853-0089		TSTR: Si PNP 2N4917	07263	2N4917	
Q8	1855-0057		TSTR: FET Si N-channel	04713	SS-3651	
Q9	1854-0298	24	TSTR: Si NPN	86684	39432 Rev. A	
Q10	1853-0036		TSTR: Si PNP 2N3906 aged	04713	SPS-3612	
Q11	1854-0071		TSTR: Si NPN 2N3391	01295	SKA1124	
R1, R2	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R3	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031	
R4	0698-4438		R: fxd met flm 3090 ohms 1% 1/4 W	14674	C4 T-O	obd
R5	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
R6, R7	0757-0448		R: fxd met flm 18.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R8	0757-0421		R: fxd met flm 825 ohms 1% 1/8 W	75042	CEA T-O	obd
R9	0757-0435		R: fxd met flm 3920 ohms 1% 1/8 W	14674	C4 T-O	obd
R10	0757-0273		R: fxd met flm 3010 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R11	0757-0450		R: fxd met flm 22.1 kilohms 1% 1/8 W	75042	CEA T-O	obd
R12	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
R13	0757-0452	2	R: fxd met flm 27.4 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R14	0757-0459	2	R: fxd met flm 56.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R15	0698-4507	1	R: fxd met flm 76.8 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R16	0757-0451		R: fxd met flm 24.3 kilohms 1% 1/8 W	75042	CEA T-O	obd
R17	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	obd
R18	0757-0447	2	R: fxd met flm 16.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R19	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O	obd
R20	0757-0442		R: fxd met flm 10 kilohms 1% 168 W	14674	C4 T-O	obd
R21	0757-0456	1	R: fxd met flm 43.2 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R22, R23	0757-0430		R: fxd met flm 2210 ohms 1% 1/8 W	14674	C4 T-O	obd
R24	0757-0447		R: fxd met flm 16.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R25	0757-0446		R: fxd met flm 15 kilohms 1% 1/8 W	75042	CEA T-O	obd
R26	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
R27	0684-1221	4	R: fxd comp 1200 ohms 10% 1/4 W	01121	CB 1221	
R28	0757-0437		R: fxd met flm 4750 ohms 1% 1/8 W	14674	C4 T-O	obd
R29	0757-0441	3	R: fxd met flm 8250 ohms 1% 1/8 W	14674	C4 T-O	obd
R30	0757-0124	2	R: fxd met flm 39.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R31	0757-0464	1	R: fxd met flm 90.9 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R32	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
A12A2	**00745-66552**		**PC Ass'y: Divider**	-hp-		
C1	0140-0198		C: fxd mica 200 pF 5% 300 vdcw	14655	RDM15F201J3C	
C2			Not assigned			
C3	0160-2960	33	C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C4, C5	0140-0220	7	C: fxd mica 200 pF 1% 300 vdcw	00853	RDM15F201F3C	
C6, C7	0160-0938	6	C: fxd mica 1000 pF 5% 100 vdcw	14655	RDM15E102J1C	
C8	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C9	0160-2202	4	C: fxd mica 75 pF 5% 300 vdcw	14655	RDM15E750J3C	
C10	0140-0151	4	C: fxd mica 820 pF 2% 300 vdcw	14655	RDM15F821G3S	
C11	0121-0036		C: var cer 5.5 - 18 pF	72982	538-006 COPO 92R	
C12	0160-0205	8	C: fxd mica 10 pF 5% 500 vdcw	14655	RDM15C100J5S	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A12A2 (Cont'd)						
C13*	0160-2202		C: fxd mica 75 pF 5% 300 vdcw	14655	RDM15E750J3C	
C14	0121-0036		C: var cer 5.5 - 18 pF	72982	538-006 COPO 92R	
C15	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C16	0160-0763		C: fxd mica 5 pF 10% 500 vdcw	00853	RDM15C050K5S	
C17	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C18	0121-0036		C: var cer 5.5 - 18 pF	72982	538-006 COPO 92R	
C19*	0140-0192	5	C: fxd mica 68 pF 5% 300 vdcw	72136	RDM15E680J3C	
C20	0160-0205		C: fxd mica 10 pF 5% 500 vdcw	14655	RDM15C100J5S	
C21	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C22	0160-0128		C: fxd cer 2.2 uF 20% 25 vdcw	56289	5C15C2-CML	
C23	0150-0093		C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA	obd
C24	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C25	0140-0177	3	C: fxd mica 400 pF 1% 300 vdcw	56289	RDM15F401F3C	
C26	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
CR1, CR2	1910-0016	6	Diode: Ge 60 piv 1 ns	14433	G718	
CR3	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
CR4	1902-3085	3	Diode: breakdown 4.75 V 5% 400 mW	04713	SZ 10939-89	
CR5, CR6	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
IC1	1820-0055	3	Integrated circuit	12040	SD8491	
L1			Not assigned			
L2 thru L4	9100-1428	9	Inductor: fxd 9.0 uH 5%	-hp-		
Q1			Not assigned			
Q2, Q3	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q4	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612	
Q5	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q6	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612	
Q7	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q8	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
R1	0698-3202	3	R: fxd met flm 1740 ohms 1% 1/8 W	14674	C4 T-O	obd
R2, R3			Not assigned			
R4	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R5	0684-1821	3	R: fxd comp 1800 ohms 10% 1/4 W	01121	CB 1821	
R6	0684-4721	8	R: fxd comp 4700 ohms 10% 1/4 W	01121	CB 4721	
R7	0684-6811	3	R: fxd comp 680 ohms 10% 1/4 W	01121	CB 6811	
R8, R9	0757-0450		R: fxd met flm 22.1 kilohms 1% 1/8 W	75042	CEA T-O	obd
R10	0757-0441		R: fxd met flm 8250 ohms 1% 1/8 W	14674	C4 T-O	obd
R11, R12			Not assigned			
R13	0684-2221	6	R: fxd comp 2200 ohms 10% 1/4 W	01121	CB 2221	
R14	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	75042	CEA T-O	obd
R15, R16	0698-3150	6	R: fxd met flm 2370 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R17	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O	obd
R18	0757-0457	4	R: fxd met flm 47.5 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R19	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R20	0757-0200		R: fxd met flm 5620 ohms 1% 1/8 W	75042	C4 T-O	obd
R21			Not assigned			
R22	0684-4701	3	R: fxd comp 47 ohms 10% 1/4 W	01121	CB 4701	
R23	0684-2201	3	R: fxd comp 22 ohms 10% 1/4 W	01121	CB 2201	
R24	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
12A2 (Cont'd)						
5	0683-6225	3	R: fxd comp 6200 ohms 5% 1/4 W	01121	CB 6225 Rev. A	
6	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
7	0684-4721		R: fxd comp 4700 ohms 10% 1/4 W	01121	CB 4721	
8	0684-1221		R: fxd comp 1200 ohms 10% 1/4 W	01121	CB 1221	
9	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
0	0757-0446		R: fxd met flm 15 kilohms 1% 1/8 W	75042	CEA T-O	obd
1	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
2	0698-4463		R: fxd met flm 845 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
	00203-84202	3	Transformer: tuned	-hp-		
2A3	**00745-66553**		**PC Ass'y: Divider**	**-hp-**		
	0140-0198		C: fxd mica 200 pF 5%	14655	RDM15F201J3C	
	0160-2204	2	C: fxd mica 100 pF 5% 300 vdcw	72136	RDM15F101J3C	
	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C5	0140-0220		C: fxd mica 200 pF 1%	00853	RDM15F201F3C	
C7	0160-0938		C: fxd mica 1000 pF 5% 100 vdcw	14655	RDM15E102J1C	
	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
	0160-2202	2	C: fxd mica 75 pF 5% 300 vdcw	14655	RDM15E750J3C	
0	0140-0151		C: fxd mica 820 pF 2% 300 vdcw	14655	RDM15F821G3S	
1	0121-0036		C: var cer 5.5 - 18 pF	72982	538-006 COPO 92R	
2	0160-0205		C: fxd mica 10 pF 5% 500 vdcw	14655	RDM15C100J5S	
3*	0140-0192		C: fxd mica 68 pF 5% 300 vdcw	72136	RDM15E680J3C	
4	0121-0036		C: var cer 5.5 - 18 pF	72982	538-006 COPO 92R	
5	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
6	0160-0205		C: fxd mica 10 pF 5% 500 vdcw	14655	RDM15C100J5S	
7	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
8	0121-0036		C: var cer 5.5 - 18 pF	72982	538-006 COPO 92R	
9*	0140-0192		C: fxd mica 68 pF 5% 300 vdcw	72136	RDM15E680J3C	
0	0160-0205		C: fxd mica 10 pF 5% 500 vdcw	14655	RDM15C100J5S	
1	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
2	0160-0128		C: fxd cer 2.2 uF 20% 25 vdcw	56289	5C15C2-CML	
3	0150-0093		C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA	obd
4	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
5	0140-0177		C: fxd mica 400 pF 1% 300 vdcw	72136	RDM15F401F3C	
6	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
1, CR2	1910-0016		Diode: Ge 60 piv 1 ma	14433	G718	
3	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
4	1902-3085		Diode: breakdown 4.75 V 5% 400 mW	04713	SZ 10939-89	
5, CR6	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
	1820-0055		Integrated circuit	12040	SD6491	
thru L4	9100-1428		Not assigned Inductor: fxd 9.0 uH 5%	-hp-		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A12A3 (Cont'd)					
Q1			Not assigned		
Q2, Q3	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611
Q4	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612
Q5	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611
Q6	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612
Q7	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611
Q8	1854-0298		TSTR: Si NPN	86684	39432 Rev. A
R1	0698-3202		R: fxd met flm 1740 ohms 1% 1/8 W	14674	C4 T-O
R2	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O
R3			Not assigned		
R4	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
R5	0684-1821		R: fxd comp 1800 ohms 10% 1/4 W	01121	CB 1821
R6	0684-4721		R: fxd comp 4700 ohms 10% 1/4 W	01121	CB 4721
R7	0684-6811		R: fxd comp 680 ohms 10% 1/4 W	01121	CB 6811
R8, R9	0757-0450		R: fxd met flm 22.1 kilohms 1% 1/8 W	75042	CEA T-O
R10	0698-4481	4	R: fxd met flm 16.5 kilohms 1% 1/8 W	14674	C4 T-O
R11			Not assigned		
R12	0698-4481		R: fxd met flm 16.5 kilohms 1% 1/8 W	14674	C4 T-O
R13	0684-2221		R: fxd comp 2200 ohms 10% 1/4 W	01121	CB 2221
R14	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O
R15, R16	0698-3150		R: fxd met flm 2370 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R17	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O
R18	0757-0457		R: fxd met flm 47.5 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R19	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
R20	0757-0200		R: fxd met flm 5620 ohms 1% 1/8 W	14674	C4 T-O
R21			Not assigned		
R22	0684-4701		R: fxd comp 47 ohms 10% 1/4 W	01121	CB 4701
R23	0684-2201		R: fxd comp 22 ohms 10% 1/4 W	01121	CB 2201
R24	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
R25	0683-6225		R: fxd comp 6200 ohms 5% 1/4 W	01121	CB 6225 Rev. A
R26	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
R27	0684-4721		R: fxd comp 4700 ohms 10% 1/4 W	01121	CB 4721
R28	0684-1221		R: fxd comp 1200 ohms 10% 1/4 W	01121	CB 1221
R29	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O
R30	0757-0446		R: fxd met flm 15 kilohms 1% 1/8 W	75042	CEA T-O
R31	0757-0442		R: fxd met flm 10 kilohms 1% 1/8 W	14674	C4 T-O
R32	0698-4463		R: fxd met flm 845 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
T1	00203-84202		Transformer: tuned	-hp-	
A12A4	**00745-66553**		**PC Ass'y: Divider (Same as A12A3)**	**-hp-**	
A12A5	**00745-66555**		**PC Ass'y: 5 MHz Oscillator and 9:1 Divider**	**-hp-**	
C1	0140-0207		C: fxd mica 330 pF 5% 500 vdcw	72136	RDM15F331J5C
C2	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7
C3	0140-0204		C: fxd mica 47 pF 5% 500 vdcw	72136	RDM15E470J5C
C4	0140-0208	1	C: fxd mica 680 pF 5% 300 vdcw	72136	RDM15E470J5C
C5	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
2A5 (Cont'd)						
	0140-0201	1	C: fxd mica 12 pF 5% 500 vdcw	72136	RDM15C120J5C	
	0140-0176		C: fxd mica 100 pF 2% 300 vdcw	72136	RDM15F101G3C	
	0140-0217	1	C: fxd mica 140 pF 2% 300 vdcw	72136	RDM15F141G3C	
	0140-0151		C: fxd mica 820 pF 2% 300 vdcw	14655	RDM15F821G3S	
)	0140-0157	1	C: fxd mica 1857 pF 1% 500 vdcw	72136	RDM20F(1857)F5S	
	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
2	0140-0178		C: fxd mica 560 pF 2% 300 vdcw	72136	RDM15F561G3C	
3	0160-0147	1	C: fxd mica 2500 pF 2% 300 vdcw	72136	RDM20F252G3S	
	9140-0029	1	Coil: R.F. choke 100 uH	99848	3100-15-101	
	00203-86009	1	Coil: var	-hp-		
thru Q4	1854-0005	4	TSTR: Si NPN 2N708	04713		obd
	0684-1521	4	R: fxd comp 1500 ohms 10% 1/4 W	01121	CB 1521	
	0684-5621	2	R: fxd comp 5600 ohms 10% 1/4 W	01121	CB 5621	
	0684-2221		R: fxd comp 2200 ohms 10% 1/4 W	01121	CB 2221	
	0684-1521		R: fxd comp 1500 ohms 10% 1/4 W	01121	CB 1521	
	0684-1231	1	R: fxd comp 12 kilohms 10% 1/4 W	01121	CB 1231	
	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031	
	0684-4721		R: fxd comp 4700 ohms 10% 1/8 W	01121	CB 4721	
	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031	
	0684-1521		R: fxd comp 1500 ohms 10% 1/4 W	01121	CB 1521	
	00203-84204		Transformer: tuned	-hp-		
	00203-84203	1	Transformer: tuned	-hp-		
	0410-0009	1	Crystal: quartz 5 MHz	75378		obd
2A6	**00745-66556**		**PC Ass'y: R.F. Amplifier**	**-hp-**		
	0140-0179	2	C: fxd mica 1000 pF 2% 300 vdcw	72136	RDM19F102G3C	
	0160-0174	1	C: fxd cer 0.47 uF +80% -20% 25 vdcw	56289	5C11B7-CML	
C4	0140-0156		C: fxd mica 1500 pF 2% 300 vdcw	72136	RDM19F152G3C	
	0140-0179		C: fxd mica 1000 pF 2% 300 vdcw	72136	RDM19F102G3C	
	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
	0150-0012	1	C: fxd cer 0.01 uF 20% 1000 vdcw	56289	29C214A3-CDH	
	0160-0944	1	C: fxd mica 1800 pF 5%	72136	RDM19F182J5C	
	0160-2198		C: fxd mica 20 pF 5% 300 vdcw	14655	RDM15C200J3C	
0, C11	0150-0084	2	C: fxd cer 0.1 uF +80% -20% 50 vdcw	72982	8131-100-651-104Z	
2	0160-2201		C: fxd mica 51 pF 5% 300 vdcw	72136	RDM15E510J3C	
3	0150-0093		C: fxd cer 0.01 uF +80% -20% 100 vdcw	91418	TA	obd
4	0160-0127	2	C: fxd cer 1 uF 20% 25 vdcw	56289	5C13C-CML	
5			Not assigned			
6	0160-0196	1	C: fxd mica 24 pF 5% 300 vdcw	72136	RDM15C240J3S	
7, C18	0180-0309		C: fxd Ta elect 4.7 uF 20% 10 vdcw	90201	TAS475M010P1A	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A12A6 (Cont'd)					
CR1	1902-0025	1	Diode: breakdown 10 V 5% 400 mW	04713	SZ 10939-152
CR2, CR3	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142
CR4	1902-3139		Diode: zener 8.25 V 5% 400 mW	04713	SZ 10939-158
L1	9140-0037	1	Coil: R.F. 5 mH	99848	35000-15-502
L2	00203-86003	1	Coil: var	-hp-	
Q1, Q2	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320
Q3 thru Q7	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611
R1	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O
R2	0757-0457		R: fxd met flm 47.5 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R3	0757-0419	2	R: fxd met flm 681 ohms 1% 1/8 W	14674	C4 T-O
R4	2100-1523	1	R: var prec ww 2000 ohms 5% 1 W	75042	CT-106-4
R5	0698-3496	1	R: fxd met flm 3570 ohms 1% 1/8 W	14674	C4 T-O
R6	0757-0440		R: fxd met flm 7500 ohms 1% 1/8 W	75042	CEA T-O
R7	0698-0064	2	R: fxd met flm 9310 ohms 1% 1/8 W	14674	C4 T-O
R8	0698-4487		R: fxd met flm 25.5 kilohms 1% 1/8 W	91637	MF-1/10-32 T-1
R9	0757-0445	1	R: fxd met flm 13 kilohms 1% 1/8 W	75042	CEA T-O
R10	0698-0064		R: fxd met flm 9310 ohms 1% 1/8 W	14674	C4 T-O
R11	0757-0419		R: fxd met flm 681 ohms 1% 1/8 W	14674	C4 T-O
R12	0698-4467	1	R: fxd met flm 1050 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1
R13	0757-0281		R: fxd met flm 2740 ohms 1% 1/8 W	75042	CEA T-O
R14, R15	0698-4421		R: fxd met flm 249 ohms 1% 1/8 W	91637	MF-1/10-32 T-1
R16	0698-3557	1	R: fxd met flm 806 ohms 1% 1/8 W	75042	CEA T-O
R17	0757-0274	1	R: fxd met flm 1210 ohms 1% 1/8 W	75042	CEA T-O
R18	0757-0427		R: fxd met flm 1500 ohms 1% 1/8 W	91637	MF-1/10-32 T-1
R19	0698-4433	1	R: fxd met flm 2260 ohms 1% 1/8 W	14674	C4 T-O
R20	0757-0429	1	R: fxd met flm 1820 ohms 1% 1/8 W	75042	CEA T-O
T1	00203-84205	1	Transformer: tuned	-hp-	
A12A7	**00745-66557**		**PC Ass'y: Modulator**	**-hp-**	
C1	0150-0093		C: fxd 0.01 uF +80% -20% 100 vdcw	91418	TA
C2	0160-0127		C: fxd cer 1 uF 20% 25 vdcw	56289	5C13C CML
C3	0150-0093		C: fxd 0.01 uF +80% -20% 100 vdcw	91418	TA
C4	0140-0220		C: fxd mica 200 pF 1% 300 vdcw	00853	RDM15F201F3C
C5	0140-0193		C: fxd mica 82 pF 5% 300 vdcw	72136	RDM15F201F3C
C6, C7	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7
C8	0140-0178		C: fxd mica 560 pF 2% 300 vdcw	72136	RDM15F561G3C
C9	0160-0128		C: fxd cer 2.2 uF 20% 25 vdcw	56289	5C15C2-CML
C10	0140-0215		C: fxd mica 80 pF 2% 300 vdcw	14655	RDM15E800G3C
C11	0160-0128		C: fxd cer 2.2 uF 20% 25 vdcw	56289	5C15C2-CML
C12	0180-0291		C: fxd Ta elect 1.0 uF 10% 35 vdcw	56289	150D105X9035A2-DYS
C13	0150-0022	1	C: fxd TiO_2 3.3 uF 10% 500 vdcw	78488	Type GA
C14	0121-0059	1	C: var cer 2 pF - 8 pF 300 vdcw	72982	538-006-COPO-89R
C15	0160-2018		C: fxd mica 250 pF 5% 500 vdcw	00853	RDM15F251J3S

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
12A7 (Cont'd)						
R1 thru CR3	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
R4 thru CR7	1901-0096	4	Diode: Si 120 V 3 pF 100 ns	01295	UG-888-1	
	9140-0237	1	Coil: 200 uH 5%	82142	15-1315-19J	
	1855-0040		TSTR: Si FET N-channel 2N3819	01295		obd
2 thru Q4	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612	
5 thru Q7	1854-0090	3	TSTR: Si NPN 2N3053	04713	SM8158	
	1854-0033		TSTR: Si NPN 2N3391	07263	S3620	
	9100-1406	1	Transformer: tuned	-hp-		
	9100-1407	1	Transformer: tuned	-hp-		
	9100-1408	1	Transformer: tuned	-hp-		
	1205-0087	3	Heat sink: TSTR	13103	1103A	
	0684-5621		R: fxd comp 5600 ohms 10% 1/4 W	01121	CB 5621	
	0757-0442		R: fxd prec met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
	0698-4505		R: fxd met flm 71.5 kilohms 1% 1/8 W	14674	C4 T-O	obd
	0684-5611	1	R: fxd comp 560 ohms 10% 1/4 W	01121	CB 5611	
	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031	
	0698-3136	1	R: fxd met flm 17.8 kilohms 1% 1/8 W	14674	C4 T-O	obd
	0757-0442		R: fxd prec met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
	0757-0459		R: fxd met flm 56.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
	0698-3453	1	R: fxd met flm 196 kilohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
0	0698-4510	1	R: fxd met flm 84.5 kilohms 1% 1/8 W	75042	CEA T-O	obd
1			Not assigned			
2	0684-2221		R: fxd comp 2200 ohms 10% 1/4 W	01121	CB 2221	
3	0684-1031		R: fxd comp 10 kilohms 10% 1/4 W	01121	CB 1031	
4	0757-0422	1	R: fxd prec met flm 909 ohms 1% 1/8 W	14674	C4 T-O	obd
5	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	obd
6	0757-0421		R: fxd met flm 825 ohms 1% 1/8 W	75042	CEA T-O	obd
7	0698-5101	1	R: fxd comp 33 ohms 10% 1/4 W	01121	CB 3301	
8	0698-4367	1	R: fxd met flm 20.5 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
9	0698-3102	1	R: fxd met flm 237 ohms 1% 1/2 W	91637	MFF-1/2-10 T-1	obd
0	0757-0991		R: fxd met flm 20 ohms 1% 1/2 W	91637	MFF-1/2-10 T-1	obd
1			Not assigned			
2	0757-0991		R: fxd met flm 20 ohms 1% 1/2 W	91637	MFF-1/2-10 T-1	obd
3	0757-0988	1	R: fxd met flm 15 ohms 1% 1/2 W	91637	MFF-1/2-10 T-1	obd
4	0757-0273		R: fxd met flm 3010 ohms 1% 1/8 W	91637	MF-1/10-32	obd
5	0698-4484	1	R: fxd met flm 19.1 kilohms 1% 1/8 W	75042	CEA T-O	obd
6	2100-2520	2	R: var lin 50 ohms 20% 1/2 W	73138	62-220-1	
7, R28	0757-0819	2	R: fxd met flm 909 ohms 1% 1/2 W	91637	MFF-1/2-10 T-1	obd
9	2100-2520		R: var lin 50 ohms 20% 1/2 W	73138	62-220-1	
0, R31	0698-4880	2	R: fxd met flm 887 ohms 1% 1/2 W	91637	MFF-1/2-10 T-1	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A12A8	**00745-66558**		**PC Ass'y: Output Amplifier**	**-hp-**		
C1	0140-0228	2	C: fxd mica 360 pF 1% 300 vdcw	72136	RDM15F361F3C	
C2	0160-0841	1	C: fxd mica 1740 pF 1% 300 vdcw	14655	RDM19F(1740)F3S	
C3	0140-0158	1	C: fxd mica 2676 pF 1% 500 vdcw	72136	RDM20F(2678)F5S	
C4	0160-0169	1	C: fxd mica 2850 pF 1% 300 vdcw	14655	RDM19F(2850)F3S	
C5, C6	0140-0199	2	C: fxd mica 240 pF 5% 300 vdcw	72136	RDM15F241J3C	
C7	0180-0197	1	C: fxd Ta elect 2.2 uF 10% 20 vdcw	90201	TAS225K020P1A	
C8	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C9	0180-0309		C: fxd Ta elect 4.7 uF 20% 10 vdcw	90201	TAS475M010P1A	
C10	0160-0945	2	C: fxd mica 910 pF 5% 100 vdcw	00853	RDM15F911J1C	
C11			Not assigned			
C12, C13	0160-2960		C: fxd cer 0.05 uF 20% 100 vdcw	56289	29C212A7	
C14	0140-0145	1	C: fxd mica 22 pF 5% 500 vdcw	72136	RDM15C220J5C	
C15	0160-2960		C: fxd mica 0.05 uF 20% 100 vdcw	56289	29C212A7	
C16	0180-0294	1	C: fxd Ta elect 390 uF 20% 10 vdcw	56289	109D397X0010T2-DYP	
C17	0160-2960		C: fxd mica 0.05 uF 20% 100 vdcw	56289	29C212A7	
C18	0160-2209	1	C: fxd mica 360 pF 5% 300 vdcw	14655	RDM15F361J3C	
C19			Not assigned			
C20	0160-2960		C: fxd mica 0.05 uF 20% 100 vdcw	56289	29C212A7	
CR1	1902-3245	1	Diode: breakdown 21.5 V 5% 400 mW	04713	SZ 10939-278	
CR2	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
L1	9100-1446	1	Inductor: fxd 0.27 mH 3%	-hp-		
L2	9100-1445	1	Inductor: fxd 0.57 mH 3%	-hp-		
L3	9100-1444	1	Inductor: fxd 0.73 mH 3%	-hp-		
Q1	1854-0221	1	TSTR: Si NPN dual	05397	BD-1148	
Q2, Q3	1853-0036		TSTR: Si PNP 2N3906	04713	SPS-3612	
Q4, Q5	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
Q6	1854-0337		TSTR: Si NPN	04713	SM1570-2	
Q7	1854-0215		TSTR: Si NPN 2N3904	04713	SPS-3611	
R1			Not assigned			
R2	0757-0435		R: fxd met flm 3920 ohms 1% 1/8 W	14674	C4 T-O	obd
R3	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	obd
R4	0698-4123		R: fxd met flm 499 ohms 1% 1/8 W	14674	C4 T-O	obd
R5	0757-0442		R: fxd prec met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
R6, R7	0757-0385		R: fxd met flm 22.1 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R8	0757-0281		R: fxd met flm 2740 ohms 1% 1/8 W	75042	CEA T-O	obd
R9	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	obd
R10	0698-4123		R: fxd met flm 499 ohms 1% 1/8 W	14674	C4 T-O	obd
R11			Not assigned			
R12	0757-0280		R: fxd met flm 1000 ohms 1% 1/8 W	14674	C4 T-O	obd
R13	0757-0450		R: fxd met flm 22.1 kilohms 1% 1/8 W	75042	CEA T-O	obd
R14	0698-4447		R: fxd met flm 280 ohms 1% 1/8 W	75042	CEA T-O	obd
R15	2100-1757		R: var ww lin 500 ohms 10% 1/2 W	75042	CT-106-4	obd
R16	0757-0124		R: fxd met flm 39.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R17	0757-0448		R: fxd met flm 18.2 kilohms 1% 1/8 W	75042	CEA T-O	obd
R18	0698-4421		R: fxd met flm 249 ohms 1% 1/8 W	91637	MF-1/10-32 T-1	obd
R19, R20	0757-0385		R: fxd met flm 22.1 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R21			Not assigned			
R22	0698-4469	1	R: fxd met flm 1150 ohms 1% 1/8 W	75042	CEA T-O	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A12A8 (Cont'd)						
R23	0757-0433		R: fxd met flm 3320 ohms 1% 1/8 W	14674	C4 T-O	obd
R24	0757-0411		R: fxd met flm 332 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R25	0684-1811	2	R: fxd comp 180 ohms 10% 1/4 W	01121	CB 1811	
R26	0757-0442		R: fxd prec met flm 10 kilohms 1% 1/8 W	14674	C4 T-O	obd
R27	0757-0446		R: fxd met flm 15 kilohms 1% 1/8 W	75042	CEA T-O	obd
R28	0757-0884	1	R: fxd met flm 3570 ohms 1% 1/4 W	75042	CCAT-O	obd
R29	0757-0401		R: fxd met flm 100 ohms 1% 1/8 W	75042	CEA T-O	obd
R30	0757-0437		R: fxd met flm 4750 ohms 1% 1/8 W	14674	C4 T-O	obd
R31			Not assigned			
R32	2100-0783	1	R: var prec ww 200 ohms 5%	75042	CT-106-4	
R33	0698-4388	1	R: fxd met flm 63.4 ohms 1% 1/8 W	75042	CEA T-O	obd
R34	0757-0407		R: fxd met flm 200 ohms 1% 1/8 W	14674	C4 T-O	obd
R35	0684-1001		R: fxd comp 10 ohms 10% 1/4 W	01121	CB 1001	
R36	0684-1811		R: fxd comp 180 ohms 10% 1/4 W	01121	CB 1811	
R37	0684-3311	2	R: fxd comp 330 ohms 10% 1/4 W	01121	CB 3311	
R38	0757-0441		R: fxd met flm 8250 ohms 1% 1/8 W	14674	C4 T-O	obd
R39	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R40	0684-1521		R: fxd comp 1500 ohms 10% 1/4 W	01121	CB 1521	
R41	0684-1211	1	R: fxd comp 120 ohms 10% 1/4 W	01121	CB 1211	
	1205-0018		Heat sink: semiconductor	05820	NF-203	
A13	**00745-66511**		**PC Ass'y: Logic**	**-hp-**		
CR1	1901-0040	16	Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
CR2	1902-3002	3	Diode: breakdown 2.37 V 5% 400 mW	04713	SZ10939-2	
CR3 thru CR9	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
CR10	1902-3002		Diode: breakdown 2.37 V 5% 400 mW	04713	SZ 10939-2	
CR11 thru CR15	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
CR16	1902-3002		Diode: breakdown 2.37 V 5% 400 mW	04713	SZ 10939-2	
CR17, CR18	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
CR19, CR20	1901-0158		Diode: Si 200 piv 0.75 A	04713	SR1358-3	
CR21	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817	
CR22	1901-0040		Diode: Si 30 piv 2 pF 30 mA 2 ns	03877	SG9142	
DS1 thru DS16	1450-0356	28	Lamp: indicator 6.3 V sub-miniature	24455	7377	
K1, K2	0490-0486		Relay: reed	-hp-		
Q1	1854-0298	19	TSTR: Si NPN	86684	39432 Rev. A	
Q2	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q3	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q4	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q5	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q6	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q7	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q8	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q9	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q10	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A13 (Cont'd)						
Q11	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q12	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q13	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q14	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q15, Q16	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q17	1851-0017		TSTR: Ge NPN 2N1304	01295	2N1304	
Q18	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q19	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q20	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q21	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q22	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q23	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q24	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q25	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q26	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q27	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q28	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q29	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q30	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
Q31	1853-0016		TSTR: Si PNP 2N3638	04713	SPS-3320	
Q32 thru Q34	1854-0298		TSTR: Si NPN	86684	39432 Rev. A	
R1	0698-4398	3	R: fxd met flm 86.6 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R2	0684-1021	20	R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R3	0684-3901	14	R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R4	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R5	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R6	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R7	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R8	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R9	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R10	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R11	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R12	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R13	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R14	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R15	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R16	0698-3558		R: fxd met flm 4020 ohms 1% 1/8 W	14674	C4 T-O	obd
R17	0684-4711		R: fxd comp 470 ohms 10% 1/4 W	01121	CB 4711	
R18	0698-4439	1	R: fxd met flm 4420 ohms 1% 1/8 W	14674	C4 T-O	obd
R19	0698-4398		R: fxd met flm 86.6 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R20	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R21	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R22	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R23	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R24	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R25	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R26	0698-4398		R: fxd met flm 86.6 ohms 1% 1/8 W	91637	CMF-1/10-32 T-1	obd
R27	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R28	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R29	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R30	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R31	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R32	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R33	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	
R34	0684-3901		R: fxd comp 39 ohms 10% 1/4 W	01121	CB 3901	
R35	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
13 (Cont'd)					
36	0684-3311		R: fxd comp 330 ohms 10% 1/4 W	01121	CB 3311
37 thru R41	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W	01121	CB 1021
42	0684-2221		R: fxd comp 2200 ohms 10% 1/4 W	01121	CB 2221
thru S16	5000-7129	16	Switch: spring	-hp-	
	1251-0498	2	Connector: pc 22 (1 x 22)	71785	252-22-30-350
	1251-2194	32	Connector: single contact	00779	3-331272-0
14	**00745-66501**		**PC Ass'y: Mother (A2 thru A7 are mounted on A14)**	-hp-	
			Not assigned		
2	0140-0228		C: fxd mica 360 pF 1% 300 vdcw	72136	RDM15F361F3C
			Not assigned		
2	9100-1405	1	Inductor: fxd 2.25 mH 3%	-hp-	
thru R6			Not assigned		
7	2100-1769	1	R: var ww trim 50 ohms 5% 1 W	75042	CT-100-4
A1			Not assigned		
A2 thru XA5	1251-2150	6	Connector: pc 22 (1 x 22)	71785	252-22-30-320
A6, XA7	1251-1999	2	Connector: pc 44 (2 x 22)	71785	252-22-30-330
	1251-2123	7	Connector: single contact (used for A14J1)	00779	331892
15	**00745-66502**		**PC Ass'y: Power Supply (A8 and A9 are mounted on A15)**	-hp-	
thru C4	0180-0353	4	C: fxd Al 450 uF +100% -10% 50 vdcw	56289	D38702
A8, XA9	1251-2150		Connector: pc 22 (1 x 22)	71785	252-22-30-320

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			Chassis Mounted Components		
C1	0180-1756	1	C: fxd Al elect 1200 uF +50% -10% 10 vdcw	56289	(34D)D42862-DSB
C2*	0160-0945		C: fxd mica 910 pF 5% 100 vdcw	00853	RDM15F911J1C
C3 thru C8			Not assigned		
C9	0132-0003	1	C: var 0.7 - 3.0 pF	72982	535-016-4R
CR1, CR2	1902-0197	2	Diode: breakdown 82.5 V 5% 1 W	04713	SZ11213-404
CR3, CR4	1901-0025		Diode: Si 100 piv 12 pF 100 mA	03877	SG-817
CR5	1901-0158		Diode: Si 200 piv 0.75 A	04713	SR1358-3
DS1	2140-0246		Lamp: incandescent 6.3 V 0.075 A	24455	1739D
F1	2110-0312	1	Fuse: slow blow (115 V usage) 2B250V 1.0 A	71400	MDL-1 Rev. B
F1	2110-0339	1	Fuse: slow blow (230 V usage) 2B250V.60A	71400	MDL-6/10
J1 thru J13			Not assigned		
J14 thru J18			(Refer to Mechanical Parts List.)		
J19	1251-0466		Connector: circular 7 contact	08524	MDR04-7S-090
	1251-0471	7	Pin: connector (for J19)	08524	800-20/30-1
J20	1251-1232	1	Connector: special purpose	-hp-	
	00745-24101	1	Cover: dust for J20	-hp-	
J21	1250-0083		Connector: counter output	24931	28JR-130-1
J22	1251-2357		Receptacle: AC power	82389	EAC-301
J23	1251-0085	1	Connector: R and P 36 contact	71785	57-40360-375
L1	9140-0083	1	Coil: R.F. 400 uH 5%	95265	SA-400-IS
L2			Not assigned		
L3, L4	9140-0136	2	Coil: fxd R.F. 22 uH 10%	82142	4424-1K
P1	1251-0325	1	Connector: test point (black)	28499	69022-1064
P2, P3	1251-0324	2	Connector: test point (red)	28499	69026-1064
P4	1251-1499		Connector: test point	71279	3308-1-03
P5 thru P18			Not assigned		
P19	00745-67603	1	Connector ass'y	-hp-	
	1251-0469	1	Connector: circular 7 contact	08524	MDR07-7P-090
	1251-0470	6	Connector: pins	08524	800-20/32-1
Q1, Q2	1854-0063	2	TSTR: Si NPN 2N3055	04713	obd
Q3 thru Q6	1854-0282	4	TSTR: Si NPN 2N3583	86684	obd
	00740-21101	1	Heat sink: for Q1, Q2	-hp-	
R1	00745-82601	1	Potentiometer: 199.9 ohms	-hp-	
R2*	0757-0450		R: fxd met flm 22.1 kilohms 1% 1/8 W	75042	CEA T-O obd
R3A R3B R4	0811-1136	1	R: matched set	-hp-	
R5	0811-2326	1	R: fxd prec ww 0.33 ohms 3% 12 W	91637	RH-10
R6	0683-1015		R: fxd comp 100 ohms 5% 1/4 W	01121	CB 1015
R7			Not assigned		
R8	0757-0283		R: fxd met flm 2000 ohms 1% 1/8 W	14674	C4 T-O obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			Chassis Mounted Components (Cont'd)		
	3101-1258	1	Switch: toggle sub-min. SPDT 5 A at 115 vac, 2 A at 250 vac	09353	7101-I
2	3101-1234	1	Switch: slide DPDT non-shorting	82389	11A-1242A
1	9100-1349	1	Inductor: divider	-hp-	
2	9100-1348	1	Transformer: lo freq. step-down	-hp-	
3	9100-1359	1	Transformer: hi freq. step-down	-hp-	
4	9100-1350	1	Transformer: lo freq. step-up	-hp-	
5	9100-1351	1	Transformer: hi freq. step-up	-hp-	
6	9100-1352	1	Transformer: power	-hp-	
A11	1200-0008	1	Socket: tube 9 pin	71785	121-25-11-029
			Cables: Main		
1	8120-1348	1	Cable: AC power	70903	KHS-7041
2	00745-67303	1	Cable: (includes XA12 thru XA14) A13 to Oscillator	-hp-	
XA12	1251-0962		Connector: pc 20 (2 x 10)	71785	252-10-30-330
XA13	00745-07602	1	Connector: flex cable	-hp-	
XA14	1251-0498		Connector: pc 22 (1 x 22)	71785	252-22-30-350
3	00745-27301	1	Cable: flex	-hp-	
4	00745-27305	1	Cable: flex	-hp-	
5	00745-27302	1	Cable: flex	-hp-	
6	00745-61609	1	Cable: remote program (includes 20 conductor ribbon and J23)	-hp-	
J23	1251-0085	1	Connector: R and P 36 contact	71785	57-40360-375
	8120-1114		Cable: ribbon 20 conductor	08261	SS-2026-7B
7	00745-61606	1	Cable: counter output (includes P3)	-hp-	
P3	1251-0324	5	Connector: test point (red)	28499	69026-1064
8	00745-61603	1	Cable: power (for line switch)	-hp-	
A11W1	00745-61602	1	Cable: readout power (includes cable, XA11A1 and A11P1)	-hp-	
	8120-0228		Cable: shielded 8 conductor	-hp-	
XA11A1	1251-1987	1	Connector: pc 20 (2 x 10)	71785	255-10-30-210
A11P1	1251-1310	1	Connector: tube base	74868	86-897
			Cables: Miscellaneous		
	00745-61601	1	Cable: decade (includes A11W1, W2, W3 and P1)	-hp-	
P1	1251-0325	1	Connector: test point (black)	28499	69022-1064
	00745-61612	1	Cable: T1 to decade (includes P1 and P2)	-hp-	
P2	1251-0324		Connector: test point (red)	28499	69026-1064

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
			Cables: Miscellaneous (Cont'd)			
	00745-61608	1	Cable: A3 to decade (includes P4)	-hp-		
	1251-1499	1	Connector: test point	71279	3308-1-03	
	00745-61610	1	Cable: 100 V feedback divider (white)	-hp-		
	00745-61611	1	Cable: 100 V feedback divider (green) (A7 to feedback divider)	-hp-		
	00745-61605	1	Cable: kilovolt amplifier (includes cable and J20)	-hp-		
	8120-0095		Cable: coaxial 60 ohm 0.833 ft.	-hp-		
J20	1251-1232	1	Connector: special purpose	-hp-		
	00745-61604	1	Cable: rear output (includes cables and J19)	-hp-		
J19	1251-0466	1	Connector: circular 7 contact	08527	MDR04-7S-090	
	1251-0471	7	Connector: pins for J19	08524	800-20/30-1	
			Mechanical Parts (Refer to Figures 6-1 and 6-2)			
MP1	2360-0200		Screw: mach 6-32 x 0.500 FH pozi	†		
MP2	5060-0749	1	Cover ass'y: top	-hp-		
MP3	00745-04106	1	Plate: top cover	-hp-		
	2360-0013		Screw: mach ss 6-32 x 1.000 RH slot (for MP3)	†		
MP4	00745-00204	1	Panel: rear	-hp-		
MP5	00745-20104		Frame ass'y: right side (viewed from front)	-hp-		
	00745-20105		Frame ass'y: left side	-hp-		
	2510-0050		Screw: mach ss 8-32 x 0.500 Phillips pozi (for MP5, 3 front screws each side)	†		
	2510-0046		Screw: mach ss 8-32 x 0.375 Phillips pozi (for MP5, 12 front screws each side)	†		
	1400-0290		Bracket: angle 90° 6-32 hole (for MP5, 4 each side)	73734	129530	
	2510-0050		Screw: mach ss 8-32 x 0.500 Phillips pozi (for angle brackets, 1 each bracket)	†		
	2580-0003		Nut: hex 8-32 x 3/8 OD (for angle brackets, 1 each bracket)	83385		obd
	3050-0026		Washer: flat brass 7/16 OD (for angle brackets, 3 each bracket)	78471		obd
MP6	5000-0747	2	Cover: side	-hp-		
MP7	2360-0190		Screw: ss 6-32 x 0.188 FH Phillips pozi	†		
MP8	5060-0222	2	Handle ass'y	-hp-		
MP9	5060-0765	2	Retainer: handle	-hp-		
MP10	2515-0017		Screw: mach ss 8-32 x 0.250 pan head Phillips pozi	†		
MP11	5060-0767	5	Foot ass'y	-hp-		
MP12	2360-0190		Screw: mach ss 6-32 x 0.188 FH Phillips pozi	†		
MP13	00745-04105	1	Cover: plate (right side)	-hp-		
	5000-0053		Cover: plate (left side)	-hp-		
MP14	5060-0761	1	Cover ass'y: bottom	-hp-		
MP15	1490-0030	1	Stand: tilt	91260	Rev. H	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			Mechanical Parts (Cont'd) **(Refer to Figures 6-1 and 6-2.)**		
MP16	00745-04107	1	Plate: bottom cover	-hp-	
	2360-0013		Screw: mach ss 6-32 x 1.000 RH slot (for MP16)	†	
MP17	5020-5368	1	Trim: panel bottom	-hp-	
MP18	00745-00201	1	Panel: front	-hp-	
MP19	1510-0010	2	Binding post: red (HI SENSE and HI OUTPUT)	-hp-	
	0340-0099		Insulator: front (for MP19)	-hp-	
	0340-0100		Insulator: rear (for MP19)	-hp-	
MP20	1510-0011	2	Binding post: black (LO SENSE, LO OUTPUT)	-hp-	
	0340-0099		Insulator: front (for MP20)	-hp-	
	0340-0100		Insulator: rear (for MP20)	-hp-	
MP21	5060-0625		Binding post ass'y: black (includes grounding strap)	-hp-	
	0340-0099		Insulator: front (for MP21)	-hp-	
MP22	0370-0768		Lens: pushbutton (white)	-hp-	
MP22	0370-0769		Lens: pushbutton (red)	-hp-	
	5000-6399		Label: LOCAL	-hp-	
	5000-6391		Label: REMOTE	-hp-	
	5000-6386		Label: X10	-hp-	
	5000-6387		Label: X100	-hp-	
	5000-6389		Label: X1K	-hp-	
	5000-6390		Label: X10K	-hp-	
	5000-6392		Label: 1 mV	-hp-	
	5000-6393		Label: 10 mV	-hp-	
	5000-6394		Label: 100 mV	-hp-	
	5000-6395		Label: 1 V	-hp-	
	5000-6396		Label: 10 V	-hp-	
	5000-6397		Label: 100 V	-hp-	
	5000-6398		Label: 1000 V ext.	-hp-	
	5000-6384		Label: 0	-hp-	
	5000-6388		Label: X.1	-hp-	
	5000-6385		Label: X1	-hp-	
MP23	0370-0766	1	End cap: right	-hp-	
MP23	0370-0765	1	End cap: left	-hp-	
MP24	0370-0767	16	Pushbutton: gray	-hp-	
MP25	0370-0149	2	Crank knob ass'y	-hp-	
MP26	00745-49302	1	Panel: window finished	-hp-	
MP27	00745-60222	1	Ass'y: face plate (includes mV and decimal lens)	-hp-	
	00745-00203	1	Plate: face	-hp-	
	00745-44301	1	Indicator: millivolt	-hp-	
	00745-44302	1	Indicator: volt	-hp-	
	00745-44303	1	Indicator: one	-hp-	
	00745-44304	4	Indicator: decimal	-hp-	
MP28	00745-20102		Trim: top	-hp-	
MP29	00745-20103		Trim: bottom	-hp-	
MP30	0370-0330		Knob: voltage-set	-hp-	
MP31	00745-04102	1	Cover: top (A1 ass'y)	-hp-	
MP32	00745-01101	1	Heatsink (A1A4)	-hp-	
MP33	00745-00606		Shield	-hp-	
MP34	00745-01102	1	Heatsink (A1A1)	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			Mechanical Parts (Cont'd) **(Refer to Figures 6-1 and 6-2.)**		
MP35			Includes the following:		
	00745-00106	1	Deck: rear	-hp-	
	00745-00107	1	Deck: front	-hp-	
	00745-05505	1	Plate: left side	-hp-	
	00745-05506	1	Plate: right side	-hp-	
	00745-05507	2	Plate: end	-hp-	
MP36			Includes the following:		
	00745-00105	1	Deck: rear	-hp-	
	00745-05504	1	Plate: rear	-hp-	
	00745-00601	1	Shield: left	-hp-	
	00745-00602	1	Shield: right	-hp-	
MP37	00745-01204	1	Bracket: TSTR	-hp-	
MP38	00745-01203	4	Bracket: chassis	-hp-	
MP39	5040-4527	12	Insulator	-hp-	
MP40			Includes the following:		
	00745-05503	2	Plate: side	-hp-	
	00745-00102	1	Support: rear deck	-hp-	
	00745-05502	1	Plate: bottom front	-hp-	
	00745-06801	2	Guide: cover front	-hp-	
	00745-00101	1	Deck: main	-hp-	
	00745-00604	1	Shield: transformer mounting	-hp-	
	00745-00605	2	Shield: pc board	-hp-	
	00745-00104	1	Support: left deck	-hp-	
	00745-06802	1	Guide: cover left	-hp-	
	00745-06803	1	Guide: cover right	-hp-	
	00745-00103	1	Support: front deck	-hp-	
	00745-00603	1	Shield: center	-hp-	
	00745-00109	1	Deck: square wave generator	-hp-	
	1200-0168	4	Socket: TSTR	22753	PTS-4 Rev. C
MP41	00745-00108	1	Deck: oscillator ass'y	-hp-	
	00745-00607	3	Shield: decade divider	-hp-	
	00745-00608	1	Shield: RF amplifier	-hp-	
	00745-00609	1	Shield: output amplifier	-hp-	
	00745-00610	1	Shield: modulator	-hp-	
	00745-04103	1	Plate: bottom cover	-hp-	
	00745-05508	1	Plate	-hp-	
MP42	00745-04104	1	Cover: plate	-hp-	
	2360-0013		Screw: mach ss 6-32 x 1.000 RH slot drive (for MP42)	†	
MP43	00745-01205		Bracket: inductor	-hp-	
MP44			Includes the following:		
	00745-01201	1	Bracket: decade	-hp-	
	00745-01208	1	Bracket: connector	-hp-	
	00745-05501	1	Plate: top front	-hp-	
	00745-06801	2	Guide: cover front	-hp-	
MP45			Includes the following:		
	2190-0022	6	Washer: lock int. No. 3/8 0.692 OD	†	
	2190-0010	6	Washer: lock ext. No. 8 0.381 OD	†	
MP46	2950-0001	6	Nut: hex 3/8 - 32 thread 1/2 in. OD	80120	
MP47	1500-0253	12	Coupler: hub brass 0.500 in. OD	99934	A-201-142
MP48	2290-0002	4	Screw: mach brass 4-40 x 0.750 FH	†	
MP49	2190-0004		Washer: lock int. No. 4 0.270 OD	†	
MP50	0520-0024	2	Screw: mach ss 2-56 binding head slot drive	†	

Table 6-1. Replaceable Parts (Cont'd)

EFERENCE ESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
			Mechanical Parts (Cont'd) (Refer to Figures 6-1 and 6-2.)			
51	2190-0014	2	Washer: int. No. 2 0.185 OD	†		
52	00745-44001	6	Dial: decades	-hp-		
53	00745-60421	1	Chassis ass'y Includes the following:	-hp-		
	00745-20101	1	Chassis: readout	-hp-		
	00745-29202	6	Pin: guide	-hp-		
	00745-29201	2	Pin: guide	-hp-		
	1410-0088	4	Bushing	71041	B46-2	
54	3030-0022		Screw: set alloy steel 6-32 x 0.125 small cup point, hex socket drive	-hp-		
55	00745-29001	2	Drum: cord drive	-hp-		
56	2190-0825		Washer: flat nylon for 1/4 in. dia. shaft	83616	W-12	
57	3030-0083		Screw: set alloy steel 2-56 x 0.188 small cup point, hex socket drive	†		
58	00745-23708	1	Shaft: freq. drive	-hp-		
59	00745-29002	1	Drum: freq. drive	-hp-		
60	1500-0004	6	Coupler: insulator nylon 1/2 in. dia.	99934	A-201-1	
61	00745-23706	2	Shaft: stop gear	-hp-		
62	5020-0233	4	Collar	-hp-		
63	3030-0020		Screw: set alloy steel 8-32 x 0.188 flat point, hex socket drive	†		
64	00745-22402	2	Gear: stop	-hp-		
65	00745-22401	2	Gear: drive	-hp-		
66	00745-23702	1	Shaft: drive	-hp-		
67	1500-0760	1	Sprocket: 30 tooth black	28425	30 by 1/4	
68	1500-0761	1	Chain: 98 links/ft.	28425		obd
69	00745-29003	1	Drum: capacitor	-hp-		
	00745-27101	1	Collar: for MP69	-hp-		
	1460-0287	2	Spring: extension 0.165 OD x 0.415 long (for MP69)	†		
70	1500-0759	2	Sprocket: 12 x 1/4 acetal resin	28425		obd
71	00745-23704	1	Shaft: extension	-hp-		
72	00745-01207	1	Bracket: idler	-hp-		
73	00745-23705	1	Shaft: idler	-hp-		
74	3050-0180		Washer: teflon white	78471		obd
75	2360-0196		Screw: mach 6-32 x 0.375 FH Phillips pozi (for both MP17 and MP28)	†		
76	00745-49901	2	Pointer: marker	-hp-		
77	1460-1003	2	Spring: extension	-hp-		
			Miscellaneous			
	5040-0235	1	Base: lampholder for overload lamp	-hp-		
	5040-0257	1	Lampholder: red (for overload lamp)	-hp-		
	2140-0246		Lamp: overload incand. 6.3 V 0.075 A T 1-3/4	08806	1739D	
	0340-0039	12	Bushing: insulator (used with following terminal posts)	98291	B-1505	
	0340-0059	9	Post: terminal (used for 100 V feedback divider and C1 mounting)	00866	Rev. A	obd
	0340-0038	3	Post: terminal (used in A12)	98291	X-L-041762-10	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
			Miscellaneous (Cont'd)		
	0340-0122	4	Bushing: nylon (used for Q1, Q2 mounting)	26365	974-303
	1400-0017		Clamp: cable nylon (red)	95987	WC-54NA
	1400-0082		Clamp: cable nylon (white)	09982	HP-2N
	0510-0738	2	Clamp: cradle nickel plated	91506	6018-18AN
	00745-67603	1	Connector ass'y: (P19)	-hp-	
	4040-0427	1	Extractor: lamp	-hp-	
	4040-0749	2	Extractor: pc board brown (for A1A1)	-hp-	
	4040-0750	2	Extractor: pc board red (for A2)	-hp-	
	4040-0751	4	Extractor: pc board orange (for A1A3 and for A3)	-hp-	
	4040-0752	4	Extractor: pc board yellow (for A1A4 and for A4)	-hp-	
	4040-0753	2	Extractor: pc board green (for A5)	-hp-	
	4040-0754	2	Extractor: pc board blue (for A6)	-hp-	
	4040-0755	2	Extractor: pc board violet (for A7)	-hp-	
	4040-0756	2	Extractor: pc board white (for A9)	-hp-	
	4040-0747	2	Extractor: pc board grey (for A8)	-hp-	
	5040-4503	5	Fastener: insulated	-hp-	
	0403-0142	2	Guide: pc board brown (for A1)	-hp-	
	0403-0143	2	Guide: pc board red	-hp-	
	0403-0144	4	Guide: pc board orange (for A1)	-hp-	
	0403-0145	4	Guide: pc board yellow (for A1)	-hp-	
	0403-0146	2	Guide: pc board green	-hp-	
	0403-0147	2	Guide: pc board blue	-hp-	
	0403-0148	2	Guide: pc board violet	-hp-	
	0403-0149	2	Guide: pc board white	-hp-	
	0403-0150	18	Guide: pc board grey (for A1 and A12)	-hp-	
	00740-21101		Heat sink	-hp-	
	1400-0084	1	Holder: fuse	75915	342014
	0340-0155	2	Insulator: TSTR (for Q1, Q2)	76530	322-011
	0340-0162	4	Insulator: TSTR (for Q3 thru Q6)	13103	obd
	00745-84401	1	Kit: accessory, Includes the following:	-hp-	
	5020-0712	1	Bracket	-hp-	
	5020-0713	1	Bracket	-hp-	
	1251-0084	1	Connector: remote program 36 contact	71785	57-30360-375
	5060-0630	1	PC ass'y: extender (22 pin)	-hp-	
	5060-0049	1	PC ass'y: extender (15 pin)	-hp-	
	5060-0091	1	PC ass'y: extender (10 pin)	-hp-	
	2510-0038	8	Screw: mach ss 8-32 x 0.312 Phillips drive	†	
	5040-0164	1	Strip: gray filler	-hp-	

† This part may be purchased from any satisfactory source.

SECTION VII
CIRCUIT DIAGRAMS

INTRODUCTION.

This section contains circuit diagrams for the Model A. Included are functional, block, schematic and ponent location diagrams.

FUNCTIONAL DIAGRAM.

The overall operation of the Model 745A is shown on functional diagram. Assemblies and significant portions ssemblies such as amplifiers and oscillators are not vn in schematic form, but are shown as triangles and ks. Circuit elements which do not lend themselves to a lified presentation, such as relays and transformers, are vn in schematic form.

BLOCK DIAGRAMS.

The overall operation of two major assemblies (A1 and A12) are shown in block diagram form in Figures 7-3 and 7-17 respectively. Circuits within these assemblies are shown on the pages following each block diagram.

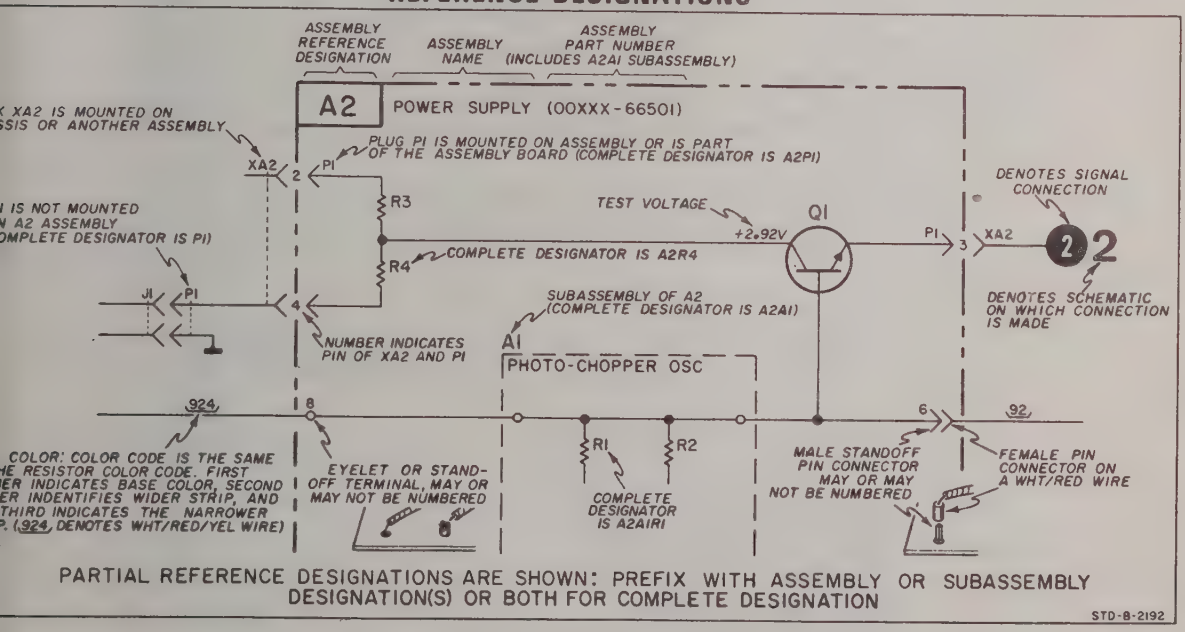
7-7. SCHEMATIC DIAGRAMS.

7-8. The circuits contained within individual replaceable assemblies are shown in the schematic diagrams. Circuits external to the assembly are drawn to show the complete function of the assembly. The schematic diagrams are arranged in ascending order of reference designation.

7-9. COMPONENT LOCATION DIAGRAMS.

7-10. Each component in the Model 745A is located by reference designation. The component location diagrams adjacent to the schematic diagrams show the physical location of each component.

REFERENCE DESIGNATIONS


ASSEMBLY REFERENCE DESIGNATION
ASSEMBLY NAME
ASSEMBLY PART NUMBER (INCLUDES A2A1 SUBASSEMBLY)
A2
POWER SUPPLY (00XXX-66501)
XA2 IS MOUNTED ON SSIS OR ANOTHER ASSEMBLY
PLUG P1 IS MOUNTED ON ASSEMBLY OR IS PART OF THE ASSEMBLY BOARD (COMPLETE DESIGNATOR IS A2P1)
XA2
P1
2
R3
TEST VOLTAGE
+2.92V
Q1
P1
3
XA2
2
DENOTES SIGNAL CONNECTION
I IS NOT MOUNTED N A2 ASSEMBLY OMPLETE DESIGNATOR IS P1)
R4
COMPLETE DESIGNATOR IS A2R4
J1
P1
4
SUBASSEMBLY OF A2 (COMPLETE DESIGNATOR IS A2A1)
DENOTES SCHEMATIC ON WHICH CONNECTION IS MADE
NUMBER INDICATES PIN OF XA2 AND P1
A1
PHOTO-CHOPPER OSC
924
8
6
92
COLOR: COLOR CODE IS THE SAME HE RESISTOR COLOR CODE. FIRST ER INDICATES BASE COLOR, SECOND ER INDENTIFIES WIDER STRIP, AND THIRD INDICATES THE NARROWER P. (924 DENOTES WHT/RED/YEL WIRE)
EYELET OR STAND-OFF TERMINAL, MAY OR MAY NOT BE NUMBERED
R1
R2
COMPLETE DESIGNATOR IS A2A1R1
MALE STANDOFF PIN CONNECTOR MAY OR MAY NOT BE NUMBERED
FEMALE PIN CONNECTOR ON A WHT/RED WIRE
PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION
STD-B-2192

GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRYS

3. DENOTES EARTH GROUND.
   USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OF AC POWER RECEPTACLE.

4. DENOTES FRAME GROUND.
   USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

5. DENOTES FLOATABLE CIRCUIT GROUND.
   USED FOR TERMINALS WHICH CAN BE FLOATED ABOVE FRAME GROUND.

6. DENOTES CIRCUIT GROUND ON PRINTED CIRCUIT ASSEMBLY.

7. DENOTES ASSEMBLY.

8. DENOTES MAIN SIGNAL PATH.

9. DENOTES FEEDBACK PATH.

10. DENOTES FRONT PANEL MARKING.

11. DENOTES REAR PANEL MARKING.

12. DENOTES SCREWDRIVER ADJUST.

13. DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.

14. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER. THE METHOD OF SELECTING THESE COMPONENTS IS DESCRIBED IN SECTION V OF THIS MANUAL.

15. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

16. (924) DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e. g. (924) = WHITE, RED, YELLOW.)

17. ALL RELAYS ARE SHOWN DEENERGIZED.

18. WAVEFORMS AND AC VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING AN OSCILLOSCOPE WITH A 10:1 DIVIDER PROBE (10 MEGOHM, 10 pF). THE VOLTAGE LEVELS SHOWN ON THE WAVEFORMS ARE ACTUAL VOLTAGE LEVELS AND ARE NOT TO BE CONFUSED WITH OSCILLOSCOPE SETTING. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER. A VARIATION OF ±10% IN MEASUREMENTS SHOULD BE ALLOWED. THE "MEASUREMENT CONDITIONS" FOR ALL AC MEASUREMENTS ARE GIVEN ON SCHEMATIC NO. 1 UNLESS OTHERWISE NOTED.

19. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A VTVM WITH 10 MEGOHM INPUT IMPEDANCE. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ±10% SHOULD BE ALLOWED.

20. # DENOTES BACKDATING CHANGE. SEE APPENDIX C.

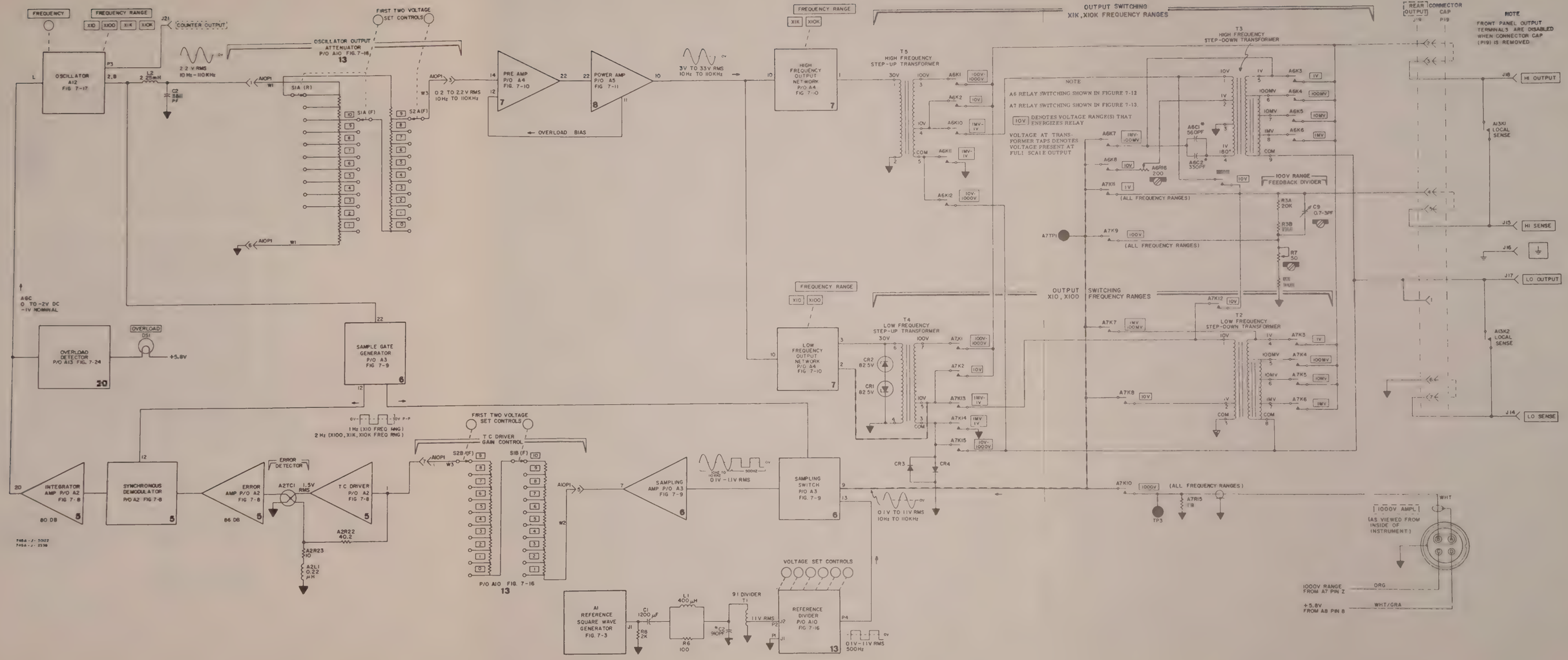
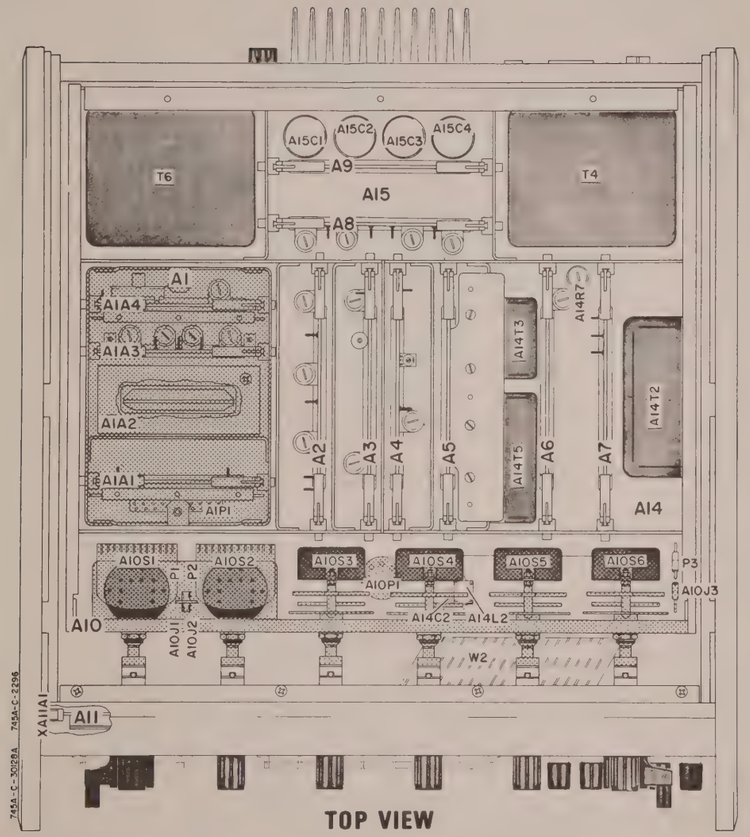

FREQUENCY
FREQUENCY RANGE
X10 X100 X1K X10K
J21 COUNTER OUTPUT
OSCILLATOR A12 FIG. 7-17
2.2 V RMS 10 Hz - 110KHz
OSCILLATOR OUTPUT ATTENUATOR P/O A10 FIG. 7-16 13
FIRST TWO VOLTAGE SET CONTROLS
S1A (R) S1A (F) S2A (F)
A10P1 W1
A10P1 W3
0.2 TO 2.2 V RMS 10Hz TO 110KHz
PRE AMP P/O A4 FIG. 7-10 7
POWER AMP P/O A5 FIG 7-11 8
OVERLOAD BIAS
3V TO 33V RMS 10Hz TO 110KHz
FREQUENCY RANGE
X1K X10K
HIGH FREQUENCY OUTPUT NETWORK P/O A4 FIG 7-10 7
OUTPUT SWITCHING X1K, X10K FREQUENCY RANGES
T5 HIGH FREQUENCY STEP-UP TRANSFORMER
T3 HIGH FREQUENCY STEP-DOWN TRANSFORMER
NOTE
A6 RELAY SWITCHING SHOWN IN FIGURE 7-12
A7 RELAY SWITCHING SHOWN IN FIGURE 7-13.
10V DENOTES VOLTAGE RANGE(S) THAT ENERGIZES RELAY
VOLTAGE AT TRANSFORMER TAPS DENOTES VOLTAGE PRESENT AT FULL SCALE OUTPUT
A6K1 A6K2 A6K10 A6K11 A6K12
A6K3 A6K4 A6K5 A6K6 A6K7 A6K8
A6C1 56PF
A6C2 330PF
A6R16 200
A7K8 A7K9
A7TP1
100V RANGE FEEDBACK DIVIDER
R3A 20K
R3B 2.5K
C9 0.7-3PF
R7 50
R8 9.45K
(ALL FREQUENCY RANGES)
REAR CONNECTOR OUTPUT J16 CAP P19
NOTE
FRONT PANEL OUTPUT TERMINALS ARE DISABLED WHEN CONNECTOR CAP (P19) IS REMOVED
J18 HI OUTPUT
A13K1 LOCAL SENSE
J15 HI SENSE
J16
J17 LO OUTPUT
A13K2 LOCAL SENSE
J14 LO SENSE
A6C
0 TO -2V DC -1V NOMINAL
OVERLOAD DETECTOR P/O A15 FIG. 7-24 20
OVERLOAD DS1
+5.8V
SAMPLE GATE GENERATOR P/O A3 FIG 7-9 6
FREQUENCY RANGE
X10 X100
LOW FREQUENCY OUTPUT NETWORK P/O A4 FIG 7-10 7
OUTPUT SWITCHING X10, X100 FREQUENCY RANGES
T4 LOW FREQUENCY STEP-UP TRANSFORMER
T2 LOW FREQUENCY STEP-DOWN TRANSFORMER
CR2 82.5V
CR1 82.5V
A7K1 A7K2 A7K13 A7K14 A7K15
A7K12
A7K7
1 Hz (X10 FREQ RNG) 2 Hz (X100, X1K, X10K FREQ RNG)
FIRST TWO VOLTAGE SET CONTROLS
T C DRIVER GAIN CONTROL
S2B (F) S1B (F)
A10P1 W3
P/O A10 FIG. 7-16 13
INTEGRATOR AMP P/O A2 FIG 7-8 5
80 DB
SYNCHRONOUS DEMODULATOR P/O A2 FIG 7-8 5
ERROR AMP P/O A2 FIG 7-8 5
86 DB
ERROR DETECTOR
A2TC1 1.5V RMS
T C DRIVER P/O A2 FIG 7-8 5
A2R22 40.2
A2R23 10
A2L1 0.22 μH
SAMPLING AMP P/O A3 FIG 7-9 6
0.1V - 1.1V RMS
SAMPLING SWITCH P/O A3 FIG. 7-9 6
CR3 CR4
0.1V TO 1.1V RMS 10Hz TO 110KHz
A7K10 1000V (ALL FREQUENCY RANGES)
A7R15 1.8
TP3
1000V AMPL (AS VIEWED FROM INSIDE OF INSTRUMENT)
WHT
1000V RANGE FROM A7 PIN Z
ORG
+5.8V FROM A8 PIN 8
WHT/GRA
VOLTAGE SET CONTROLS
A1 REFERENCE SQUARE WAVE GENERATOR FIG. 7-3
C1 1200 μF
L1 400 μH
R6 100
R8 2K
C2 9KPF
91 DIVIDER T1
1.1V RMS
REFERENCE DIVIDER P/O A10 FIG. 7-16 13
0.1V - 1.1V RMS 500Hz

Figure 7-1. Functional Diagram



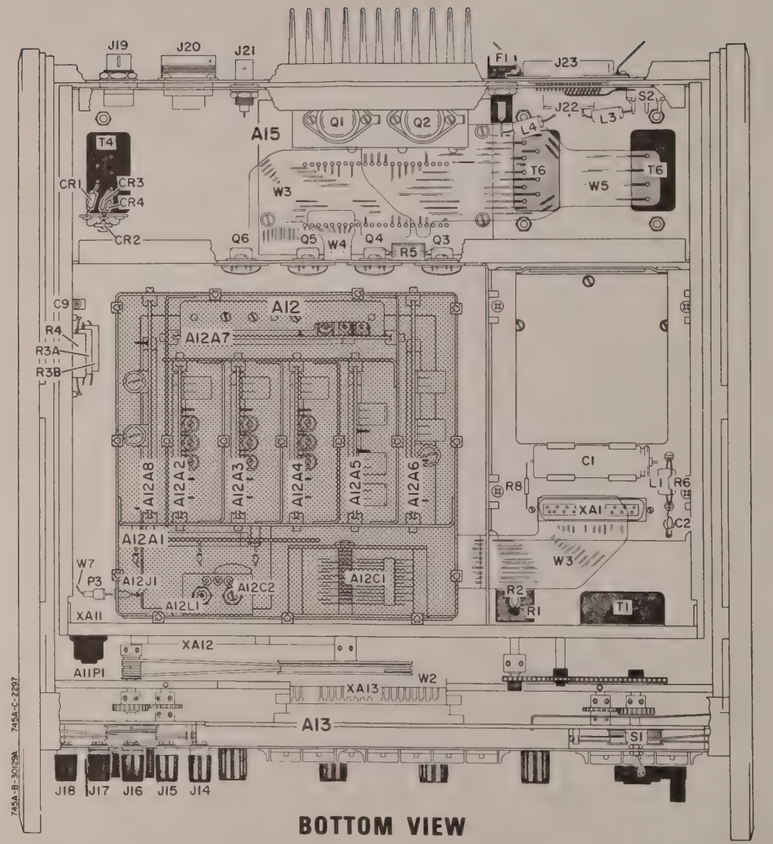
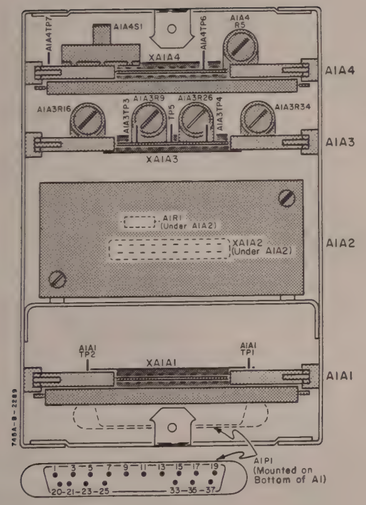


Figure 7-2. Chassis Top and Bottom View



A1

hp Part No. 00745-66940

(A1 Mother Board, Rev A Only — *hp* Part No. 00745-66546)

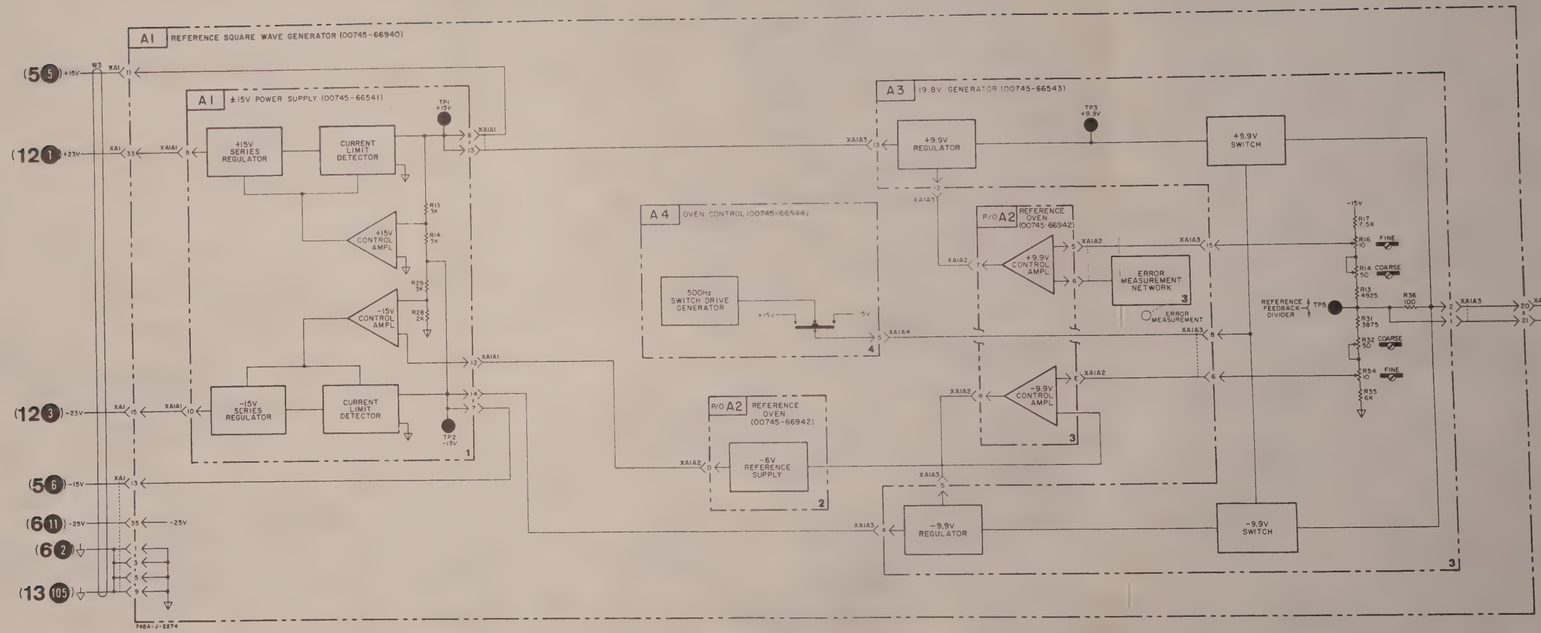
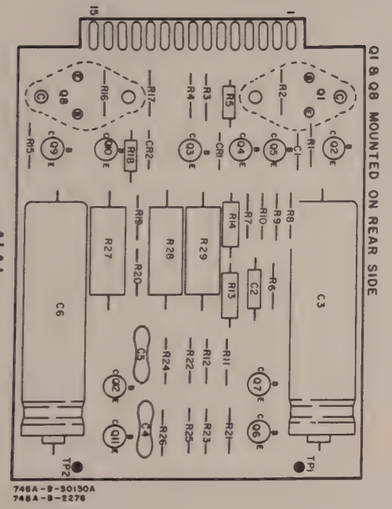


Figure 7-3. Reference Square Wave Generator (A1) Block Diagram



A1A1
hp Part No. 00745-66541
Rev A

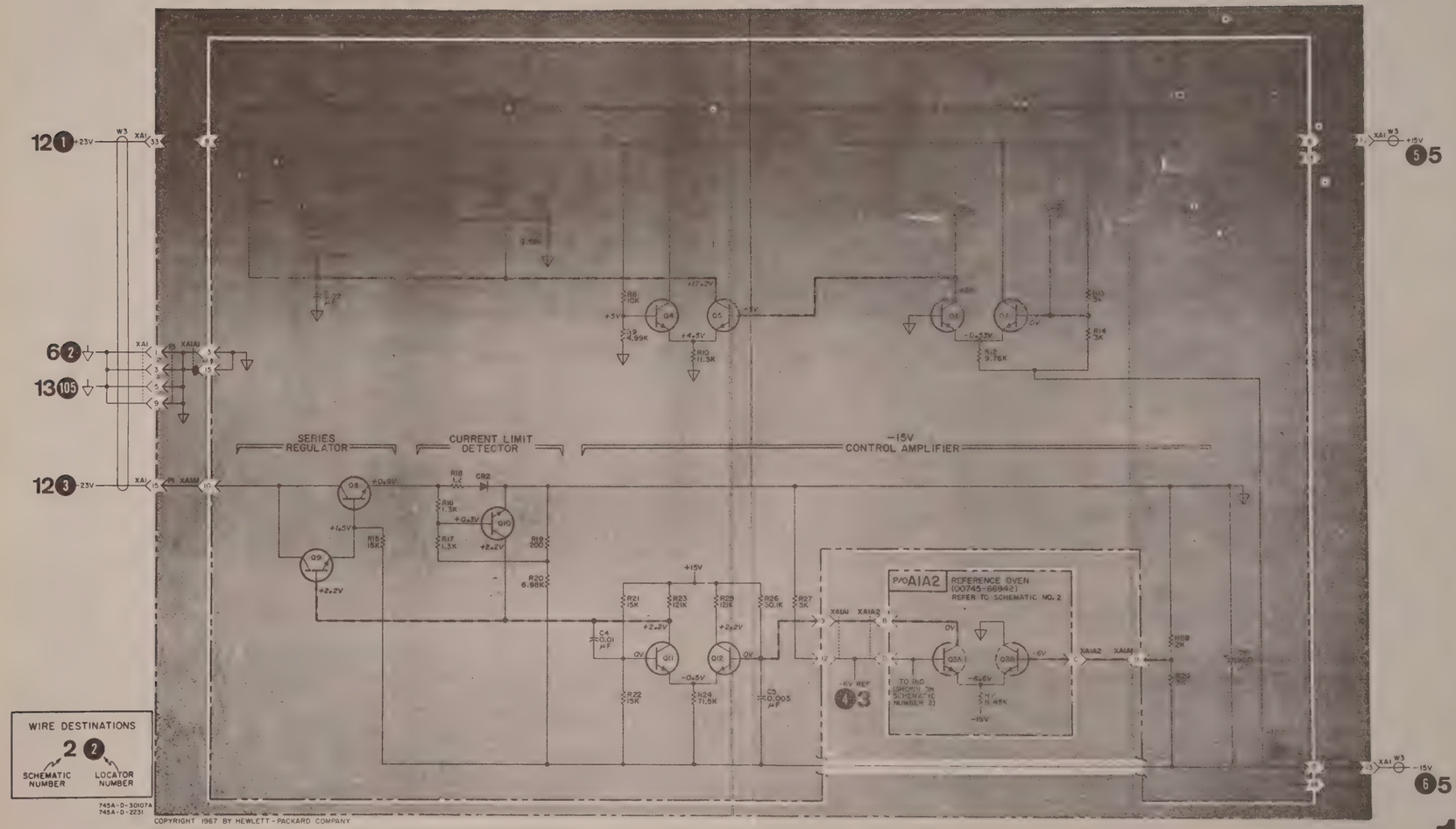
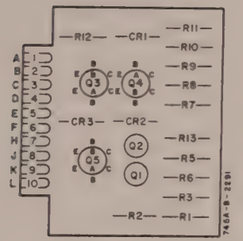


Figure 7-4. + and -15 V Power Supply (A1A1) Schematic and Component Location Diagram



A1A2A1
hp Part No. 00745-66545
Rev A

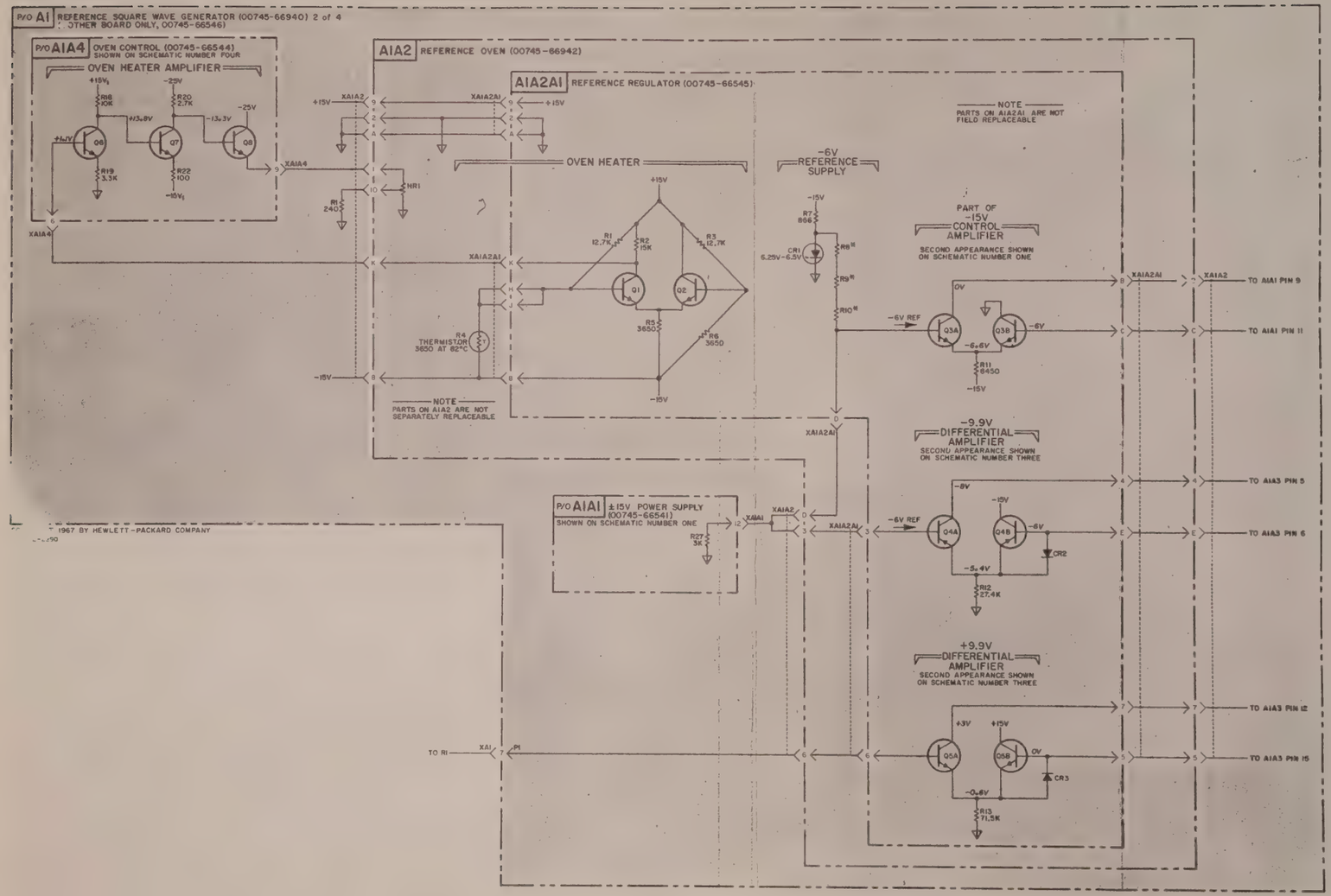
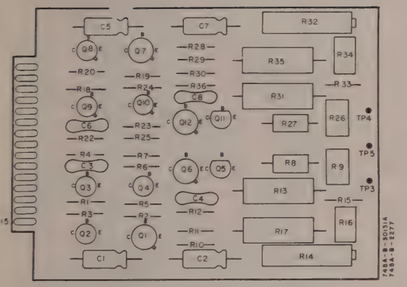

P/O A1 REFERENCE SQUARE WAVE GENERATOR (00745-66940) 2 of 4
: OTHER BOARD ONLY, 00745-66546)
P/O A1A4 OVEN CONTROL (00745-66544)
SHOWN ON SCHEMATIC NUMBER FOUR
OVEN HEATER AMPLIFIER
A1A2 REFERENCE OVEN (00745-66942)
A1A2A1 REFERENCE REGULATOR (00745-66545)
NOTE
PARTS ON A1A2A1 ARE NOT FIELD REPLACEABLE
OVEN HEATER
-6V REFERENCE SUPPLY
PART OF -15V CONTROL AMPLIFIER
SECOND APPEARANCE SHOWN ON SCHEMATIC NUMBER ONE
-9.9V DIFFERENTIAL AMPLIFIER
SECOND APPEARANCE SHOWN ON SCHEMATIC NUMBER THREE
+9.9V DIFFERENTIAL AMPLIFIER
SECOND APPEARANCE SHOWN ON SCHEMATIC NUMBER THREE
THERMISTOR 3650 AT 82°C
NOTE
PARTS ON A1A2 ARE NOT SEPARATELY REPLACEABLE
P/O A1A1 ±15V POWER SUPPLY (00745-66541)
SHOWN ON SCHEMATIC NUMBER ONE
TO A1A1 PIN 9
TO A1A1 PIN 11
TO A1A3 PIN 5
TO A1A3 PIN 6
TO A1A3 PIN 12
TO A1A3 PIN 15
TO R1
1967 BY HEWLETT-PACKARD COMPANY

Figure 7-5. Reference Oven (A1A2) Schematic and Component Location Diagram



AIA3

hp Part No. 00745-66543

Rev A

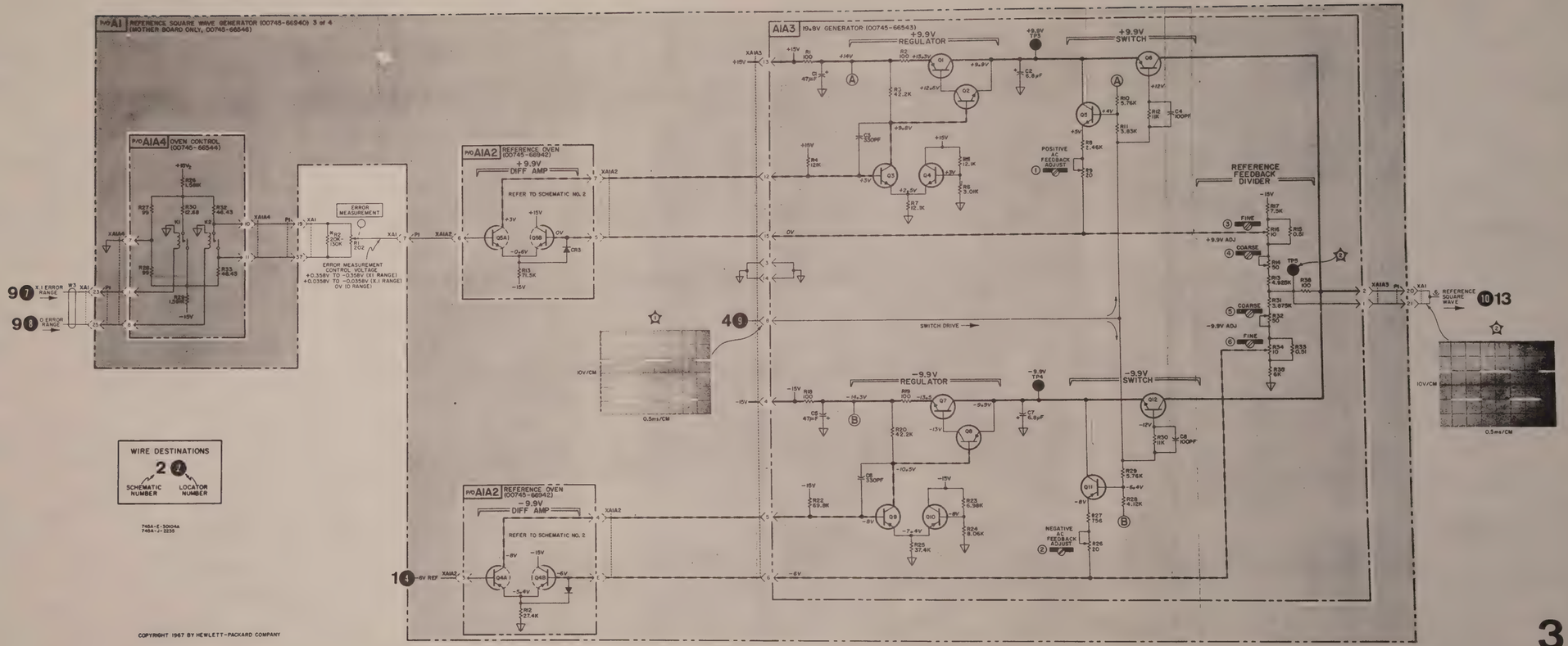
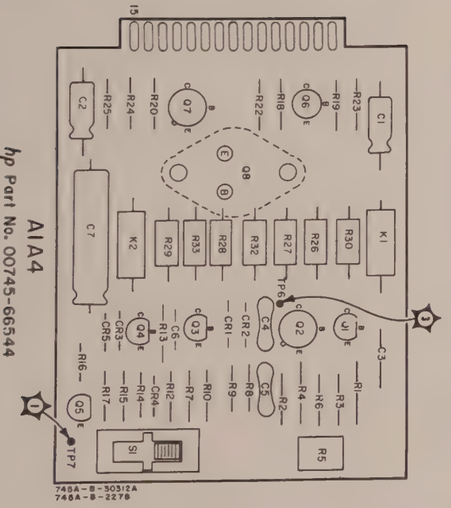

A1 REFERENCE SQUARE WAVE GENERATOR (00745-66940) 3 of 4 (MOTHER BOARD ONLY, 00745-66546)
A4 OVEN CONTROL (00745-66544)
A2 REFERENCE OVEN (00745-66942) +9.9V DIFF AMP
A2 REFERENCE OVEN (00745-66942) -9.9V DIFF AMP
REFER TO SCHEMATIC NO. 2
ERROR MEASUREMENT
ERROR MEASUREMENT CONTROL VOLTAGE +0.358V TO -0.358V (X1 RANGE) +0.0358V TO -0.0358V (X.1 RANGE) 0V TO RANGE
AIA3 19.8V GENERATOR (00745-66543)
+9.9V REGULATOR
+9.9V SWITCH
-9.9V REGULATOR
-9.9V SWITCH
REFERENCE FEEDBACK DIVIDER
POSITIVE ADJ FEEDBACK ADJUST
NEGATIVE ADJ FEEDBACK ADJUST
SWITCH DRIVE
9 X.1 ERROR RANGE
9 X.01 ERROR RANGE
4 9
10 13 REFERENCE SQUARE WAVE
14 -6V REF
10V/CM
0.5ms/CM
WIRE DESTINATIONS
2 SCHEMATIC NUMBER
1 LOCATOR NUMBER
7465A-E-50044
7465A-J-2230
COPYRIGHT 1967 BY HEWLETT-PACKARD COMPANY

Figure 7-6. 19.8 V Square Wave Generator (A1A3) Schematic and Component Location Diagram



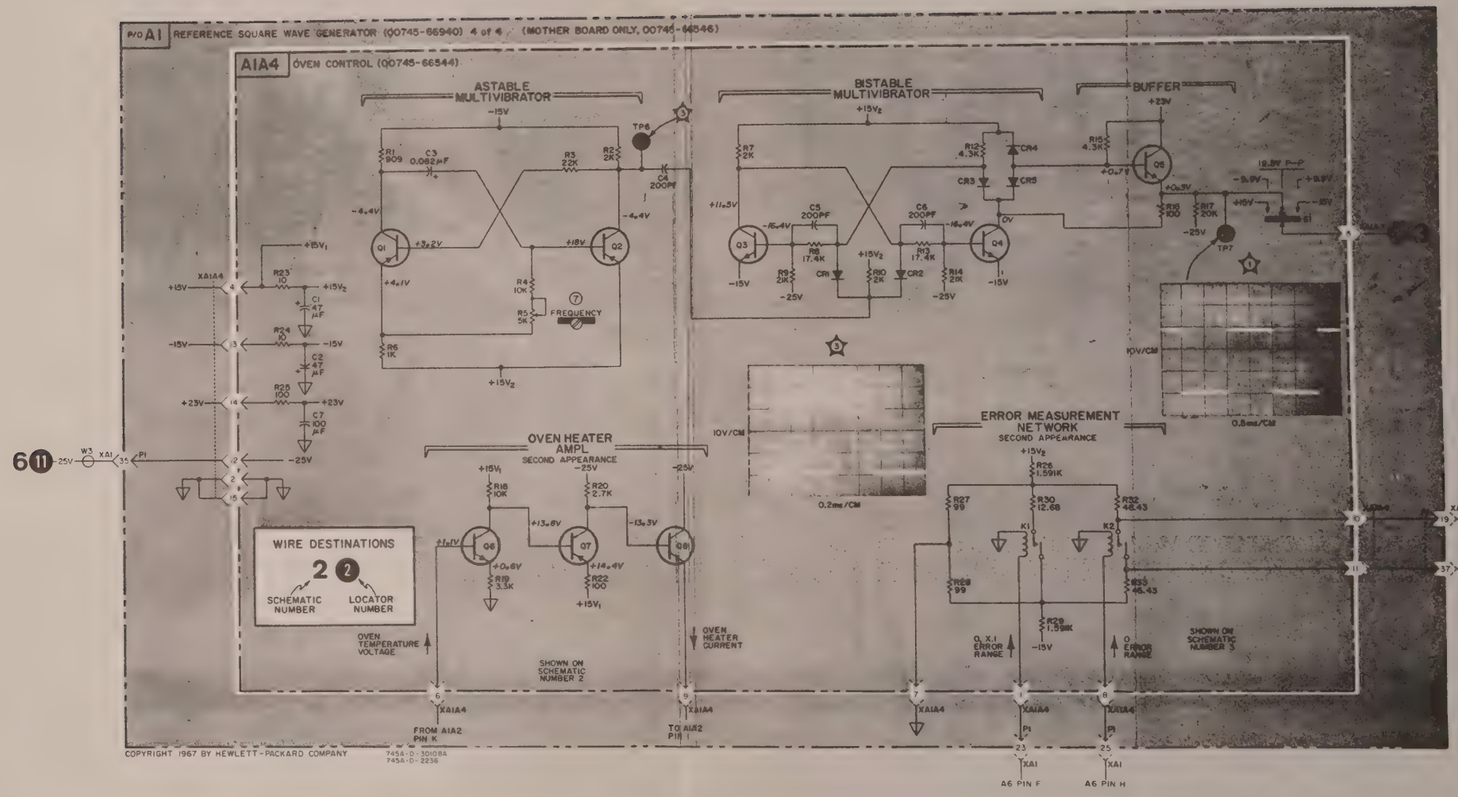


Figure 7-7. Oven Control and Switch Drive Generator (A1A4) Schematic and Component Location Diagram

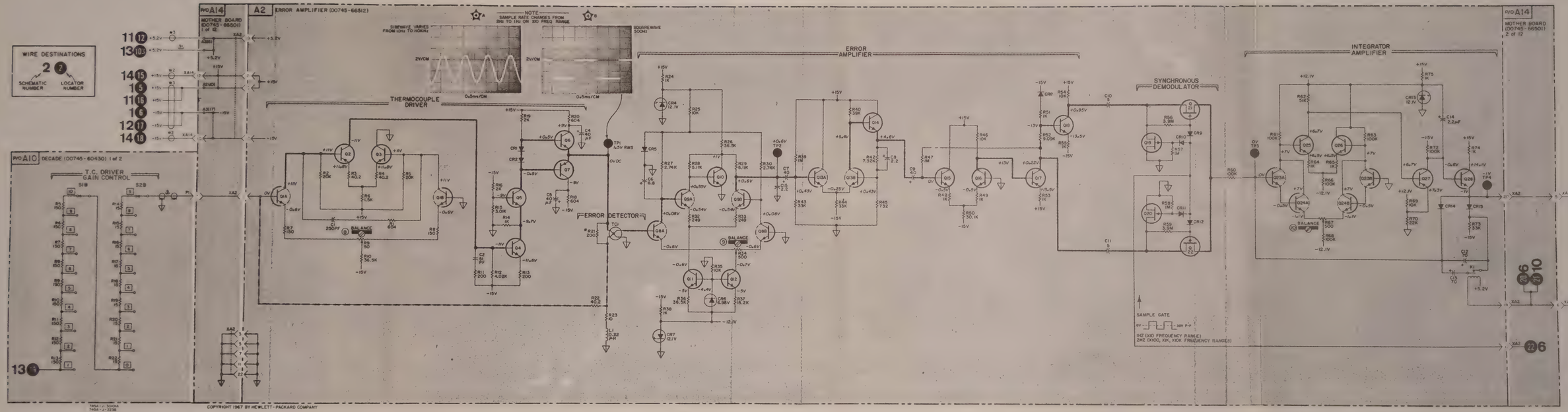
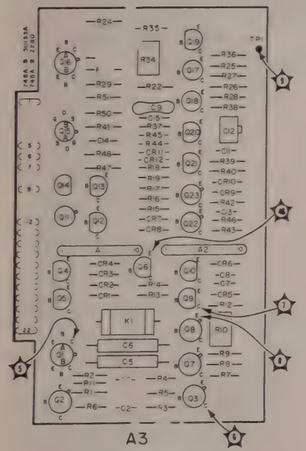


Figure 7-8. Error Amplifier (A2) Schematic and Component Location Diagram



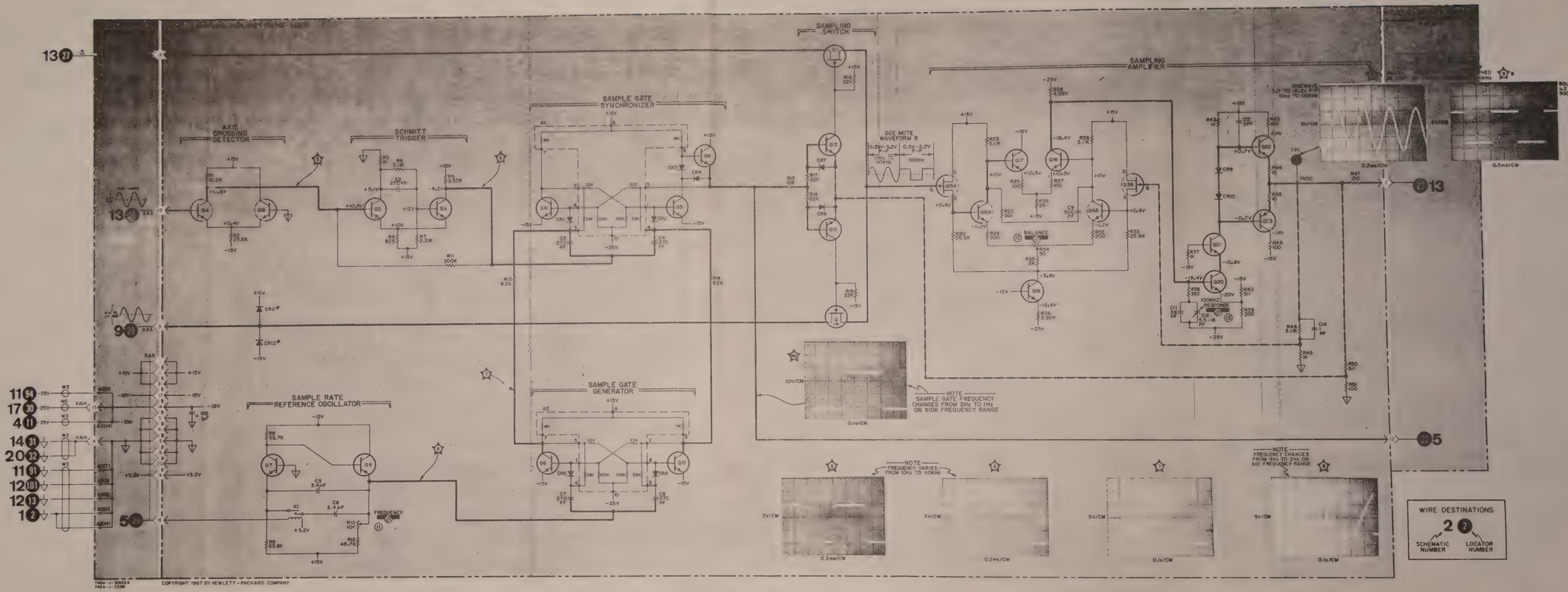
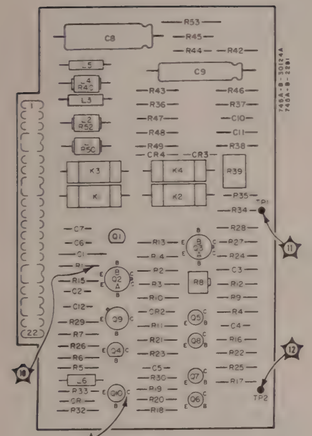


Figure 7-9. Sampling Amplifier (A3) Schematic and Component Location Diagram



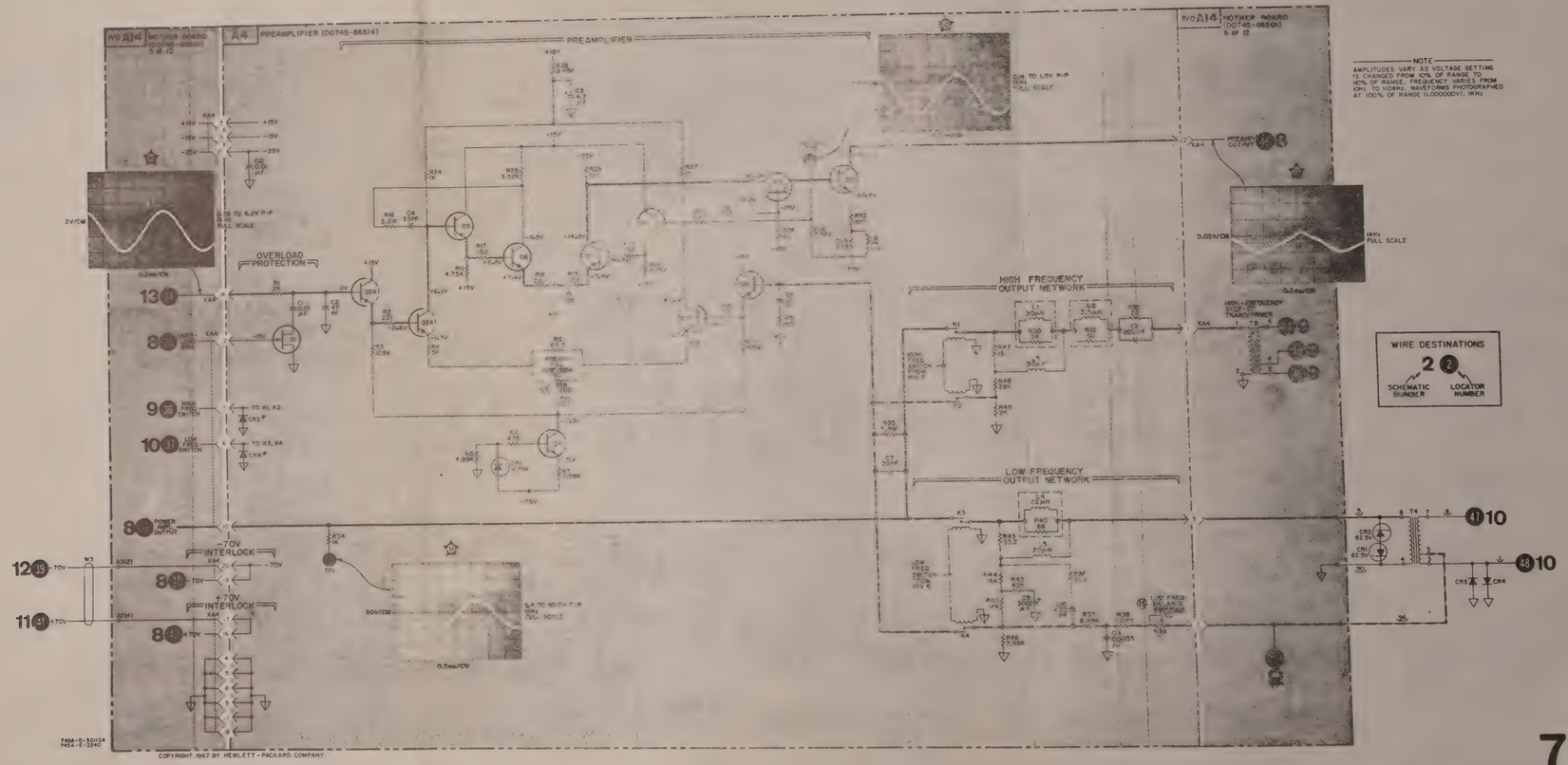
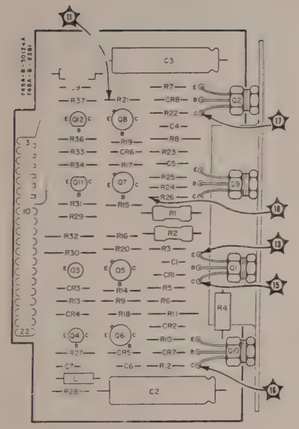
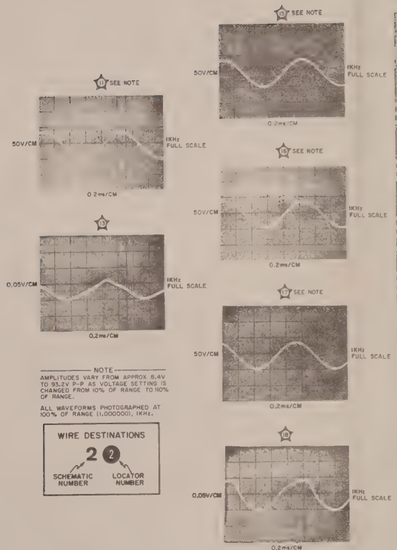

A4 PREAMPLIFIER (00745-66514)
PREAMPLIFIER
OVERLOAD PROTECTION
HIGH FREQUENCY OUTPUT NETWORK
LOW FREQUENCY OUTPUT NETWORK
INTERLOCK
-70V INTERLOCK
+70V INTERLOCK
NOTE
AMPLITUDES VARY AS VOLTAGE SETTING IS CHANGED FROM 10% OF RANGE TO 100% OF RANGE. FREQUENCY VARIES FROM 10Hz TO 100KHz. WAVEFORMS PHOTOGRAPHED AT 100% OF RANGE (1.000000V), 1KHz
WIRE DESTINATIONS
SCHEMATIC NUMBER
LOCATOR NUMBER
COPYRIGHT 1967 BY HEWLETT-PACKARD COMPANY

Figure 7-10. Preamplifier (A4) Schematic and Component Location Diagram





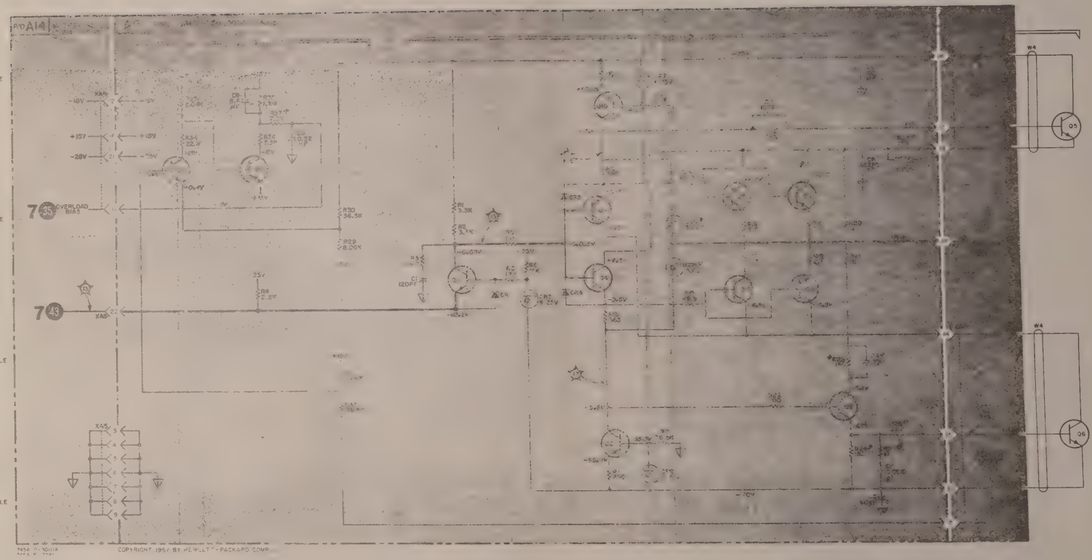
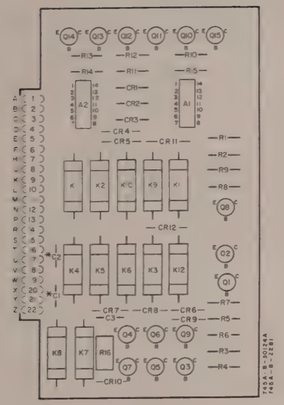


Figure 7-11. Power Amplifier (A5) Schematic and Component Location Diagram



A6
hp Part No. 00745-66516
Rev B

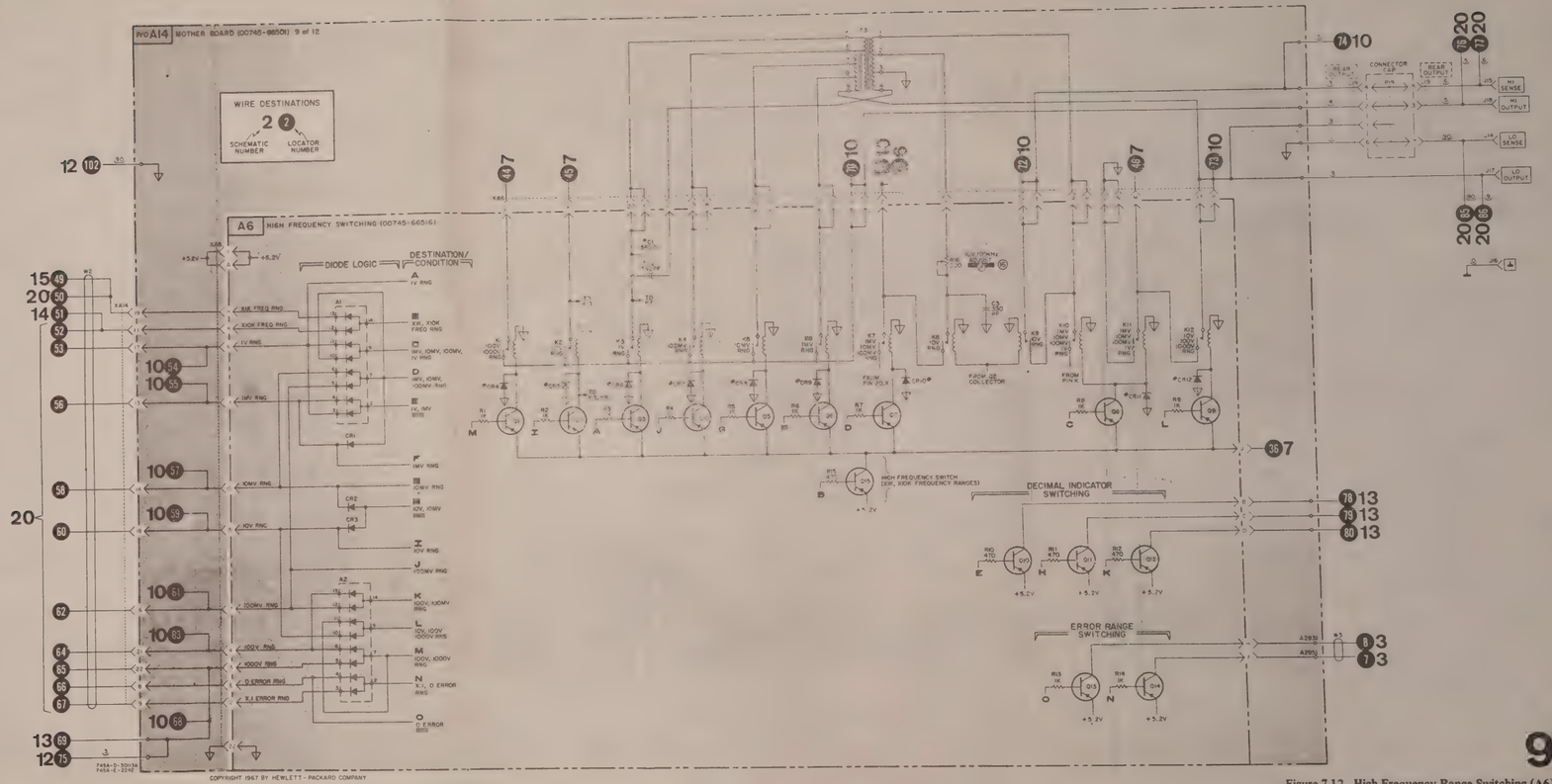
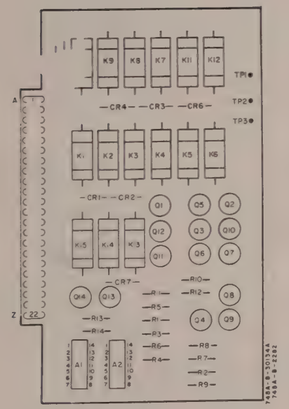


Figure 7-12. High Frequency Range Switching (A6) Schematic and Component Location Diagram



A7

hp Part No. 00745-66517

Rev C

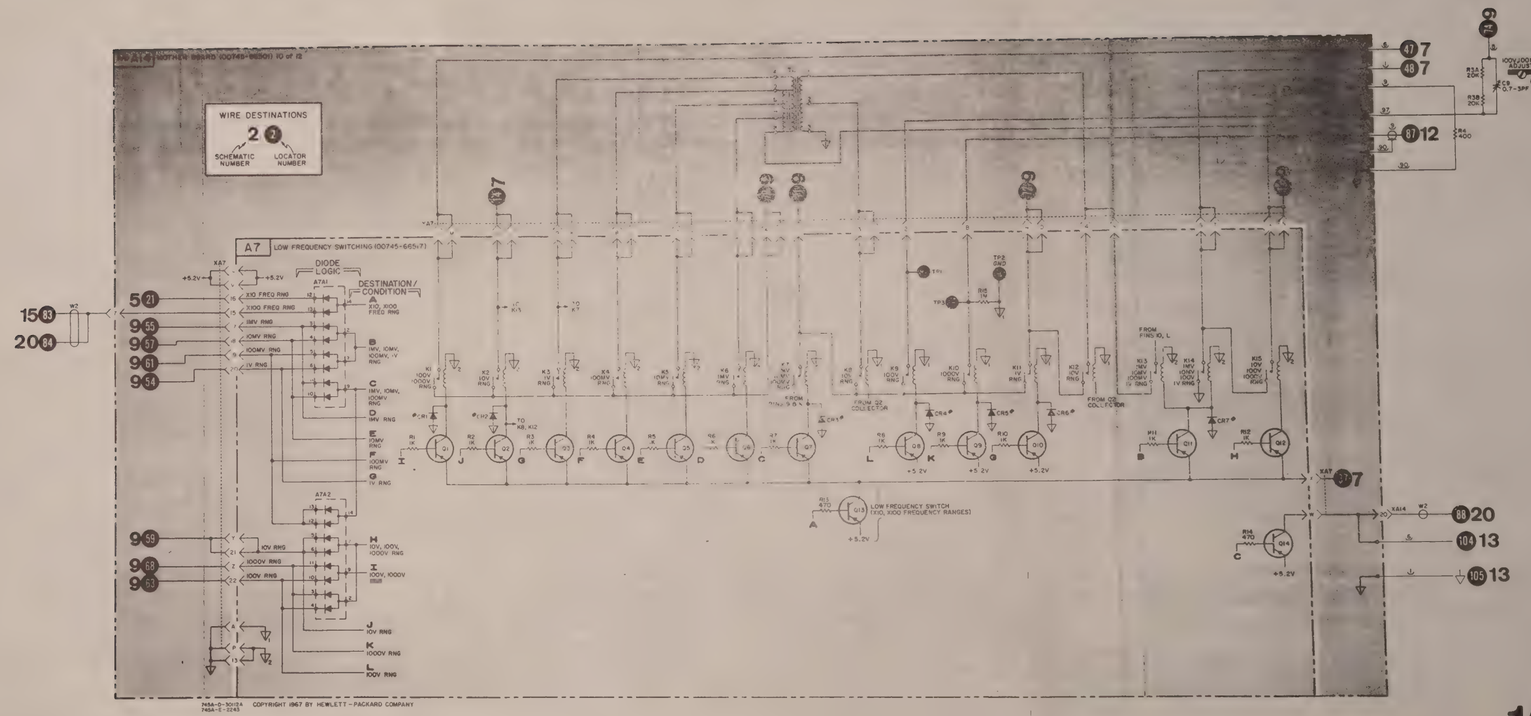
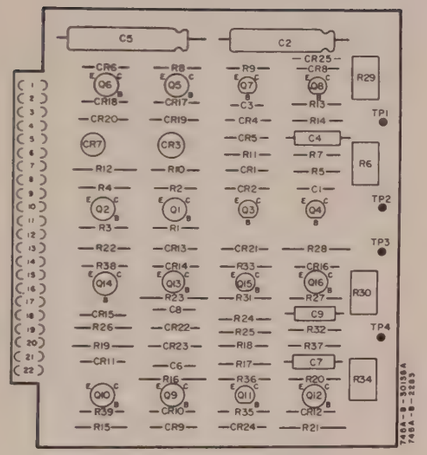


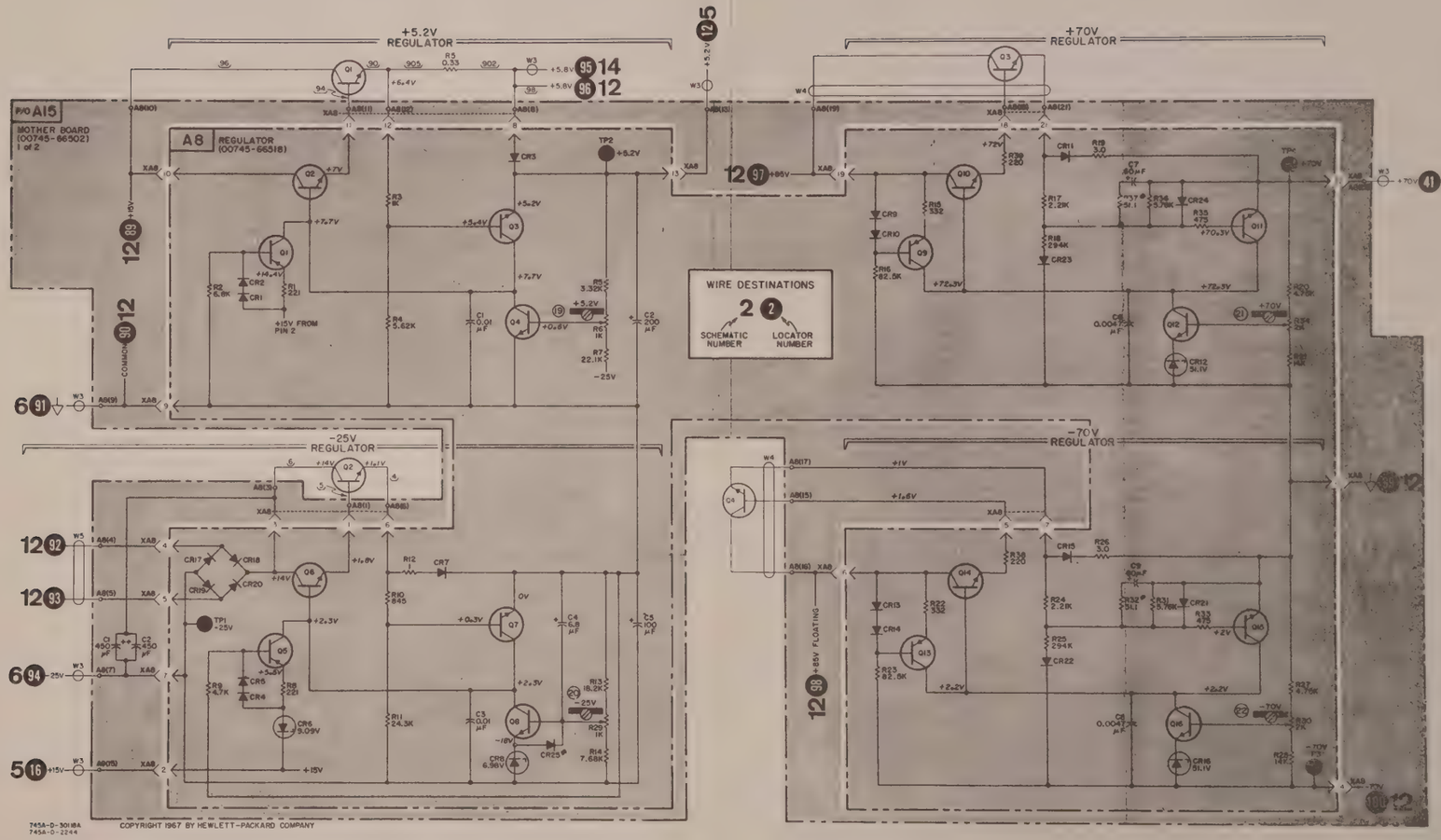
Figure 7-13. Low Frequency Range Switching (A7) Schematic and Component Location Diagram



A8

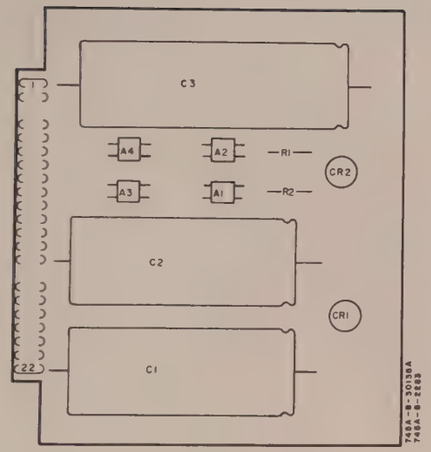
hp Part No. 00745-66518

Rev B



11

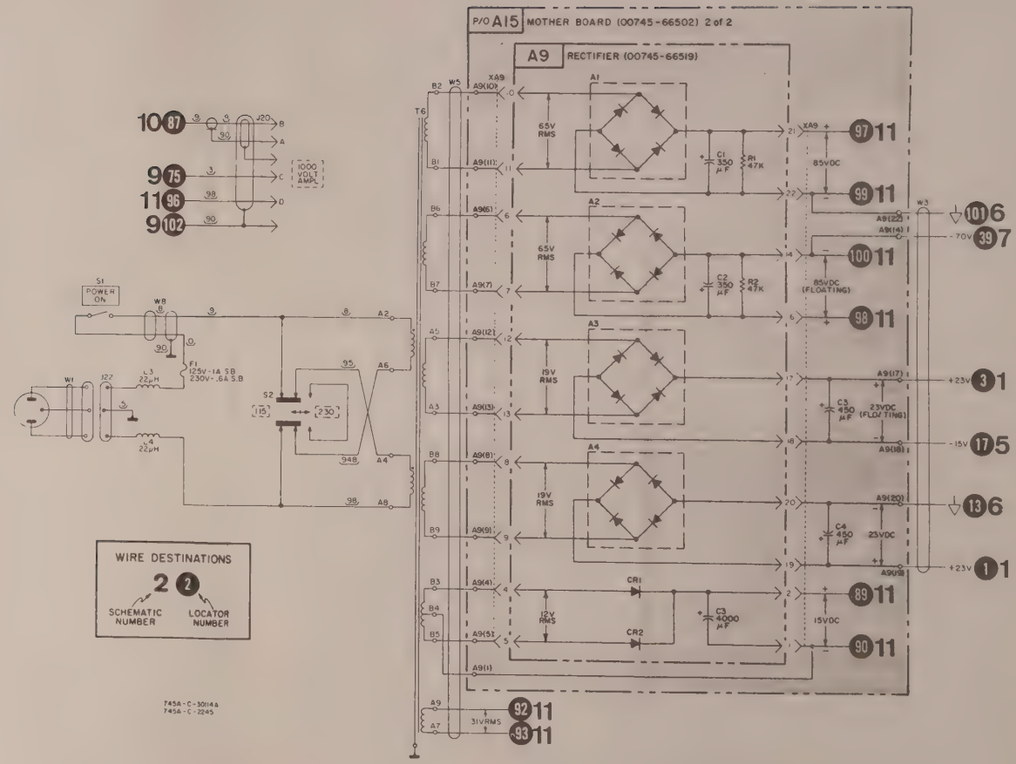
Figure 7-14. Regulated Power Supply (A8) Schematic and Component Location Diagram



A9

hp Part No. 00745-66519

Rev A



12

Figure 7-15. Primary Power Supply (A9) Schematic and Component Location Diagram

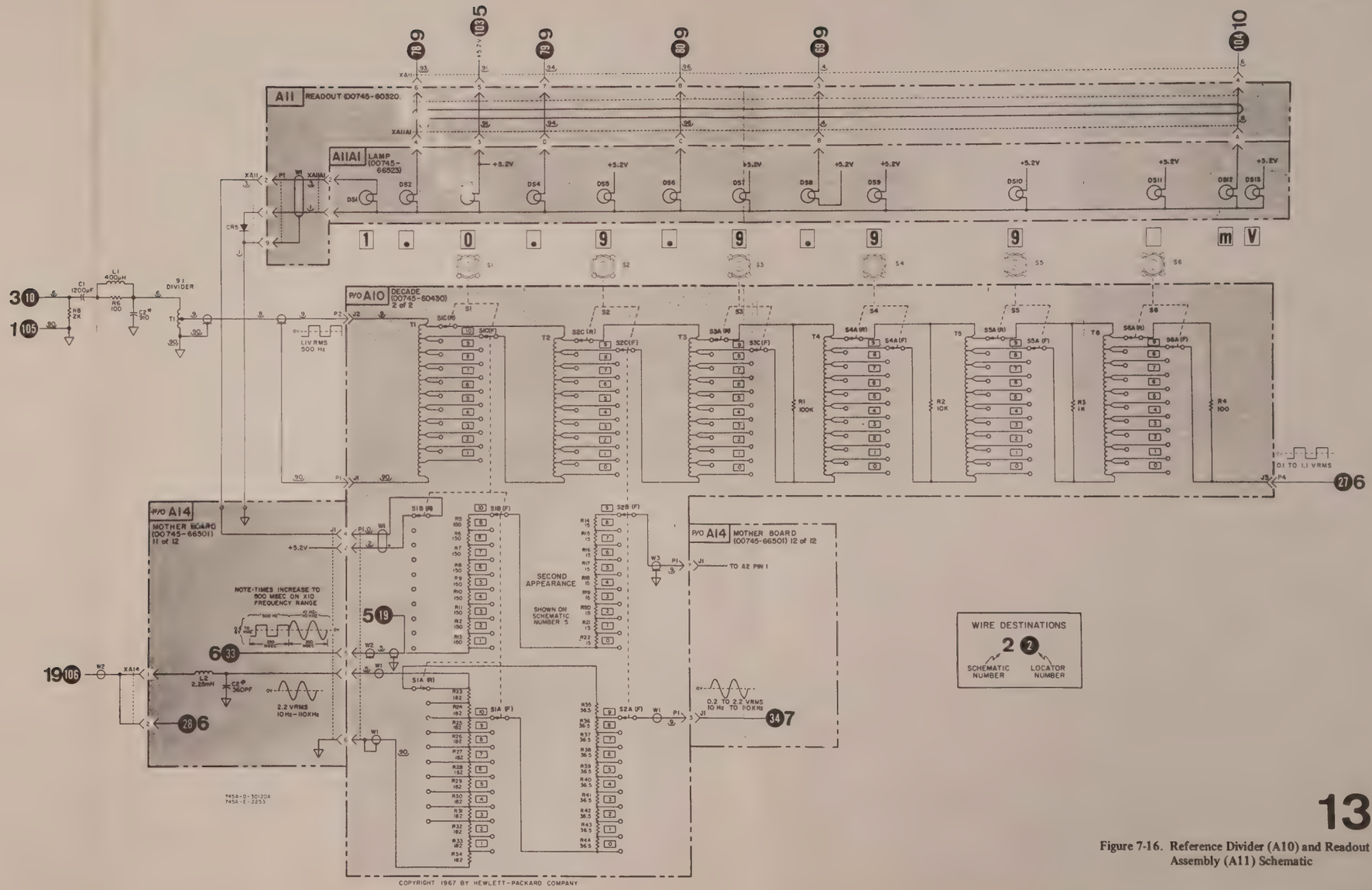
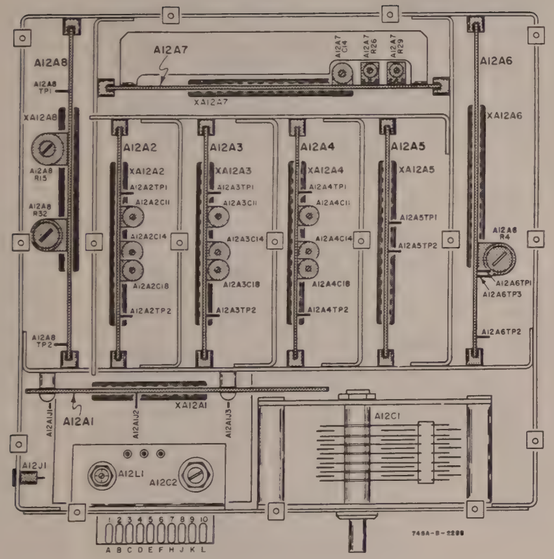

A11 READOUT (00745-60320)
A11A1 LAMP (00745-66523)
P/O A10 DECADE (00745-60430) 2 of 2
P/O A14 MOTHER BOARD (00745-66501) 11 of 12
P/O A14 MOTHER BOARD (00745-66501) 12 of 12
SECOND APPEARANCE
SHOWN ON SCHEMATIC NUMBER 5
NOTE-TIMES INCREASE TO 500 MSEC ON X10 FREQUENCY RANGE
2.2 VRMS 10 Hz–110KHz
0.2 TO 2.2 VRMS 10 Hz TO 110KHz
0.1 TO 1.1 VRMS
1.1V RMS 500 Hz
9:1 DIVIDER
TO A2 PIN 1
WIRE DESTINATIONS
SCHEMATIC NUMBER
LOCATOR NUMBER
7458-D-301208
7458-E-2253
COPYRIGHT 1967 BY HEWLETT-PACKARD COMPANY

Figure 7-16. Reference Divider (A10) and Readout Assembly (A11) Schematic



A12

hp Part No. 00745-65950

(A12 Mother Board, Rev A Only — *hp* Part No. 00745-66559)

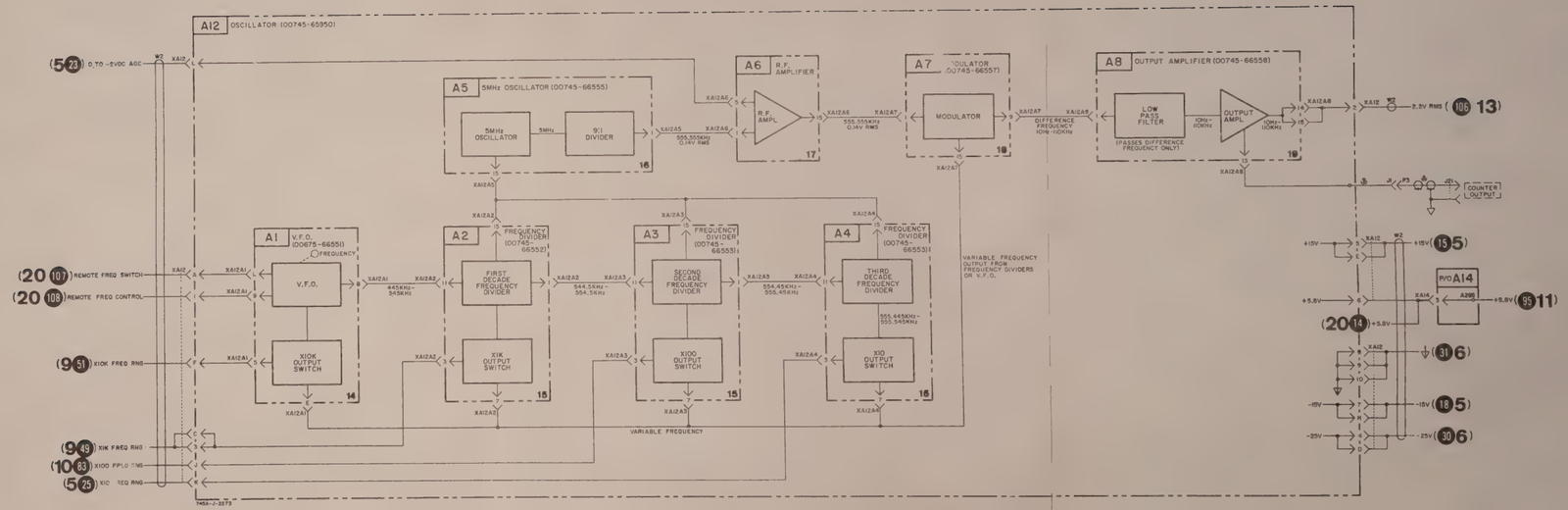
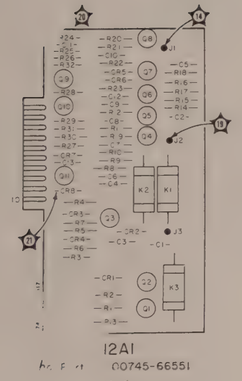


Figure 7-17. Oscillator (A12) Block Diagram



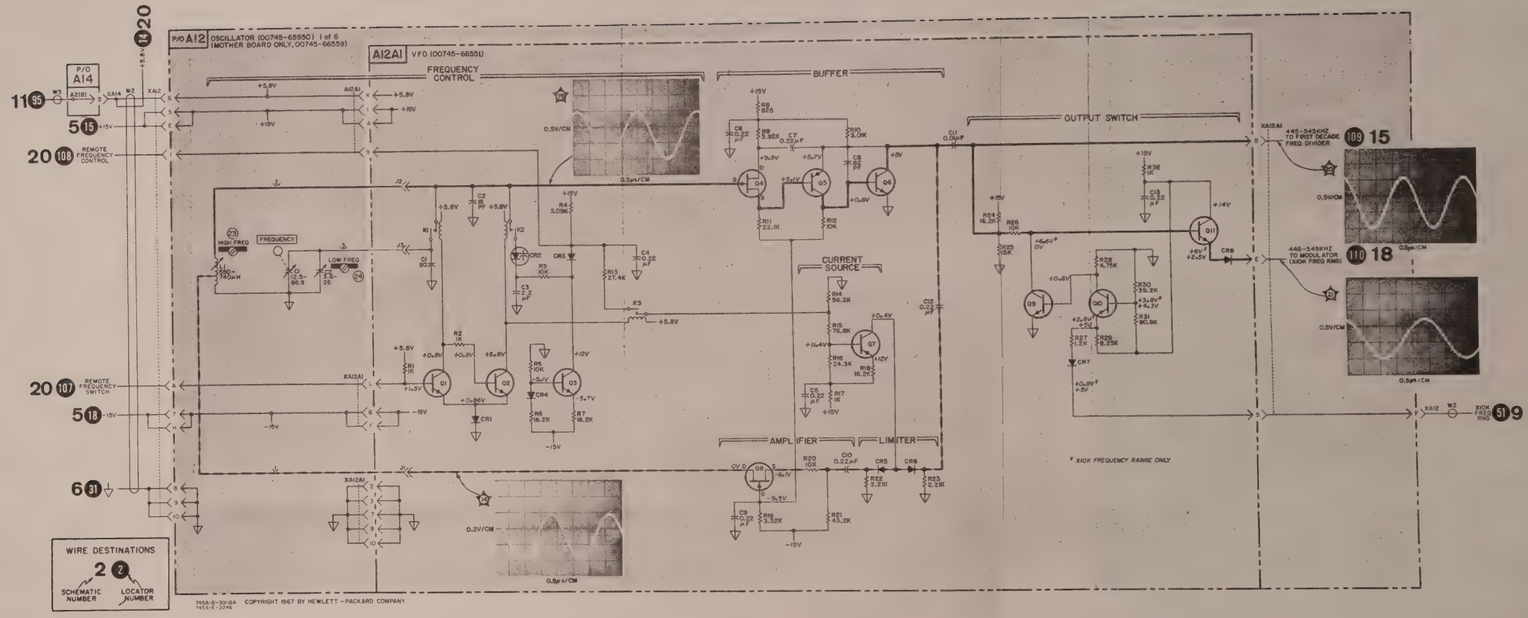
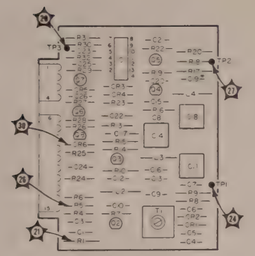


Figure 7-18. Variable Frequency Oscillator (A12A1) Schematic and Component Location Diagram

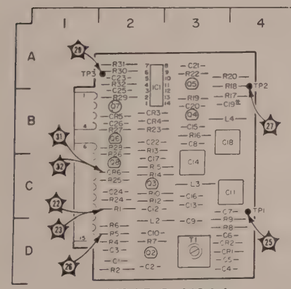


A12A2

hp Part No. 00745-66552

Rev B

745A-B-30138A
745A-B-2288

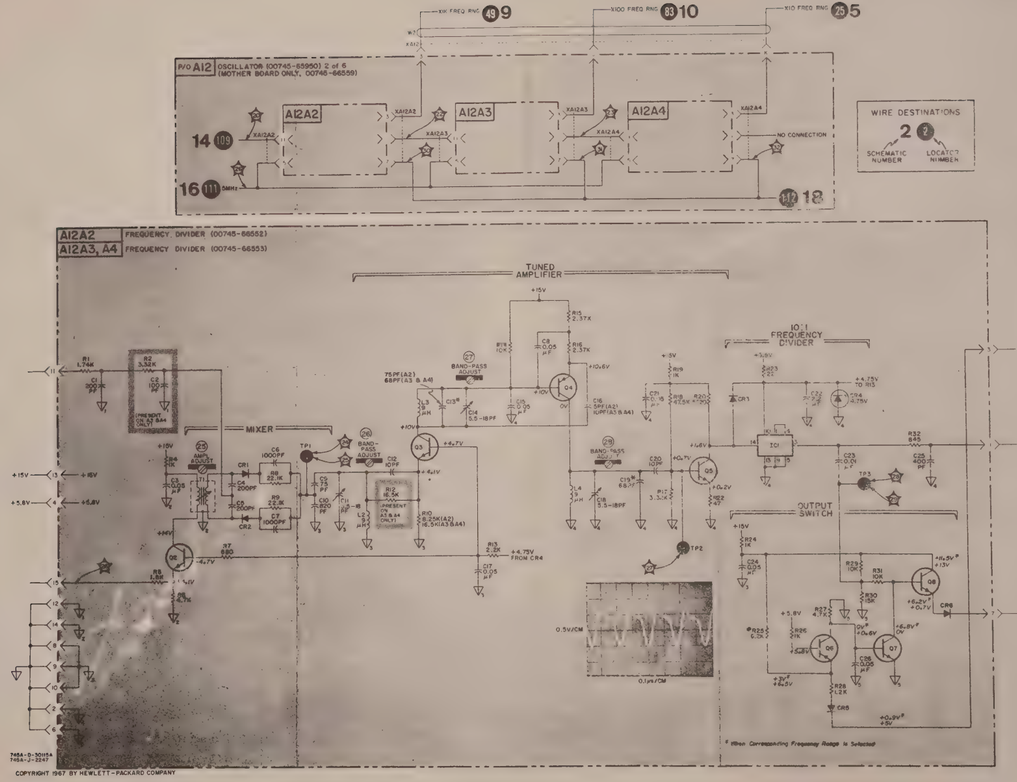


A12A3 & A12A4

hp Part No. 00745-66553

Rev C

745A-B-30138A
745A-B-2284



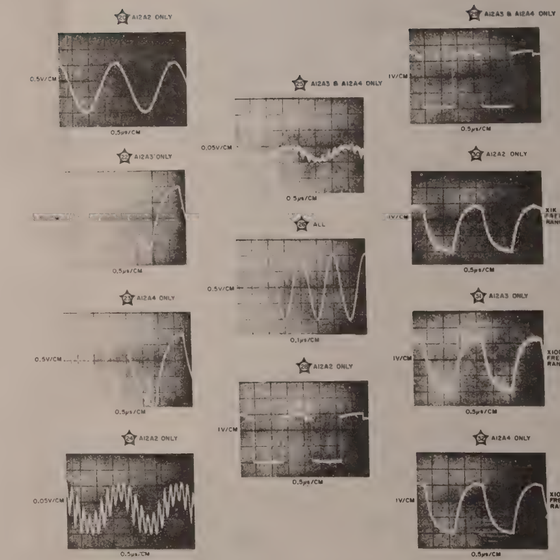
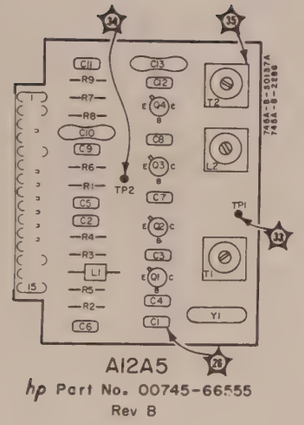


Figure 7-19. Decade Frequency Dividers (A12A2 - A4) Schematic and Component Location Diagram



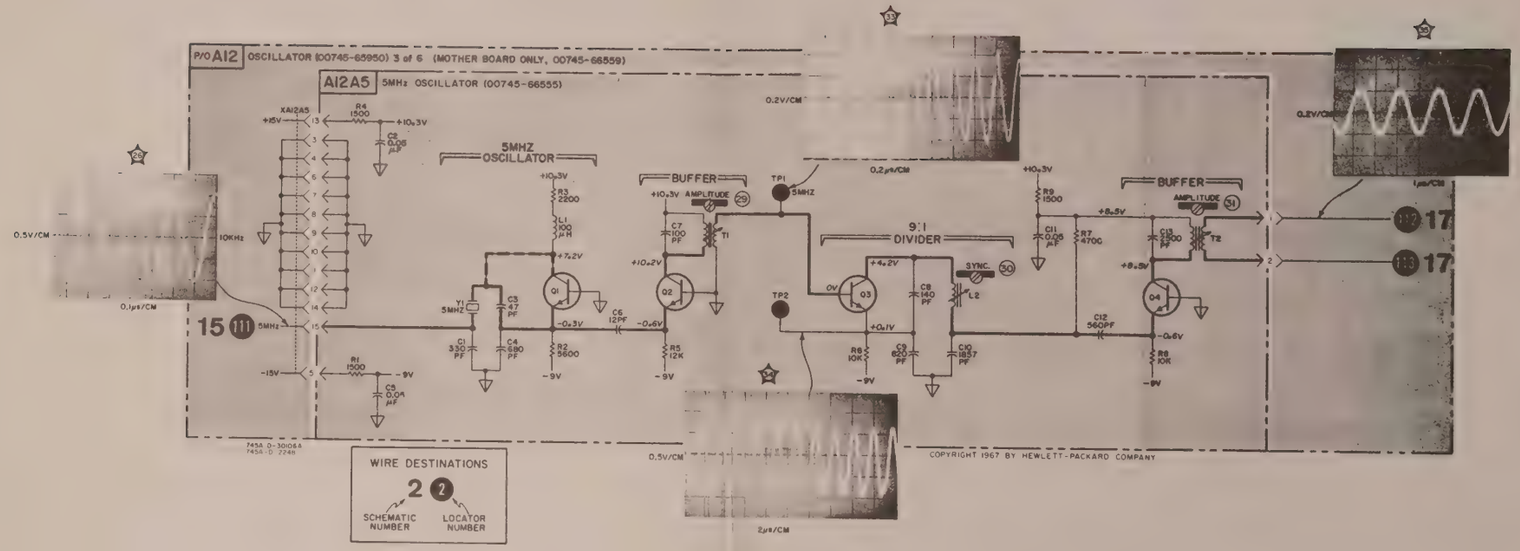
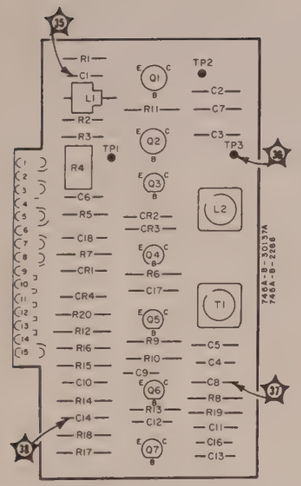
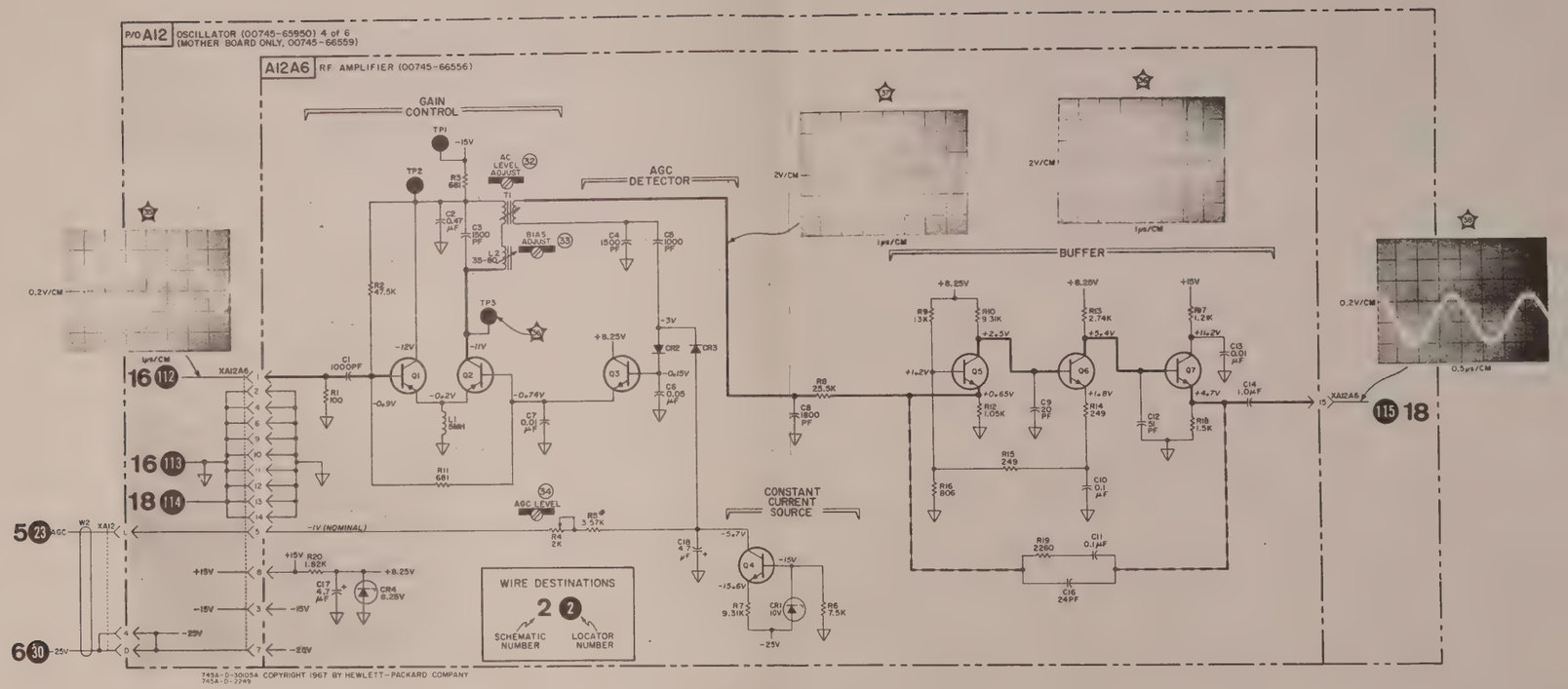


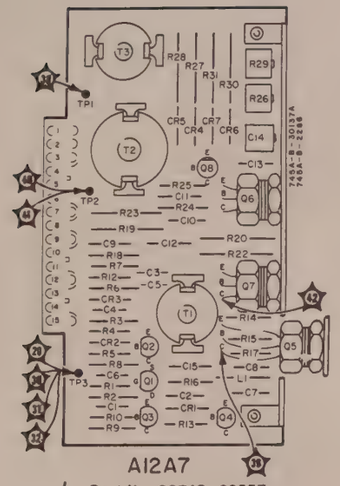
Figure 7-20. 5 MHz Oscillator and 9:1 Divider (A12A5) Schematic and Component Location Diagram





17

Figure 7-21. RF Amplifier (A12A6) Schematic and Component Location Diagram



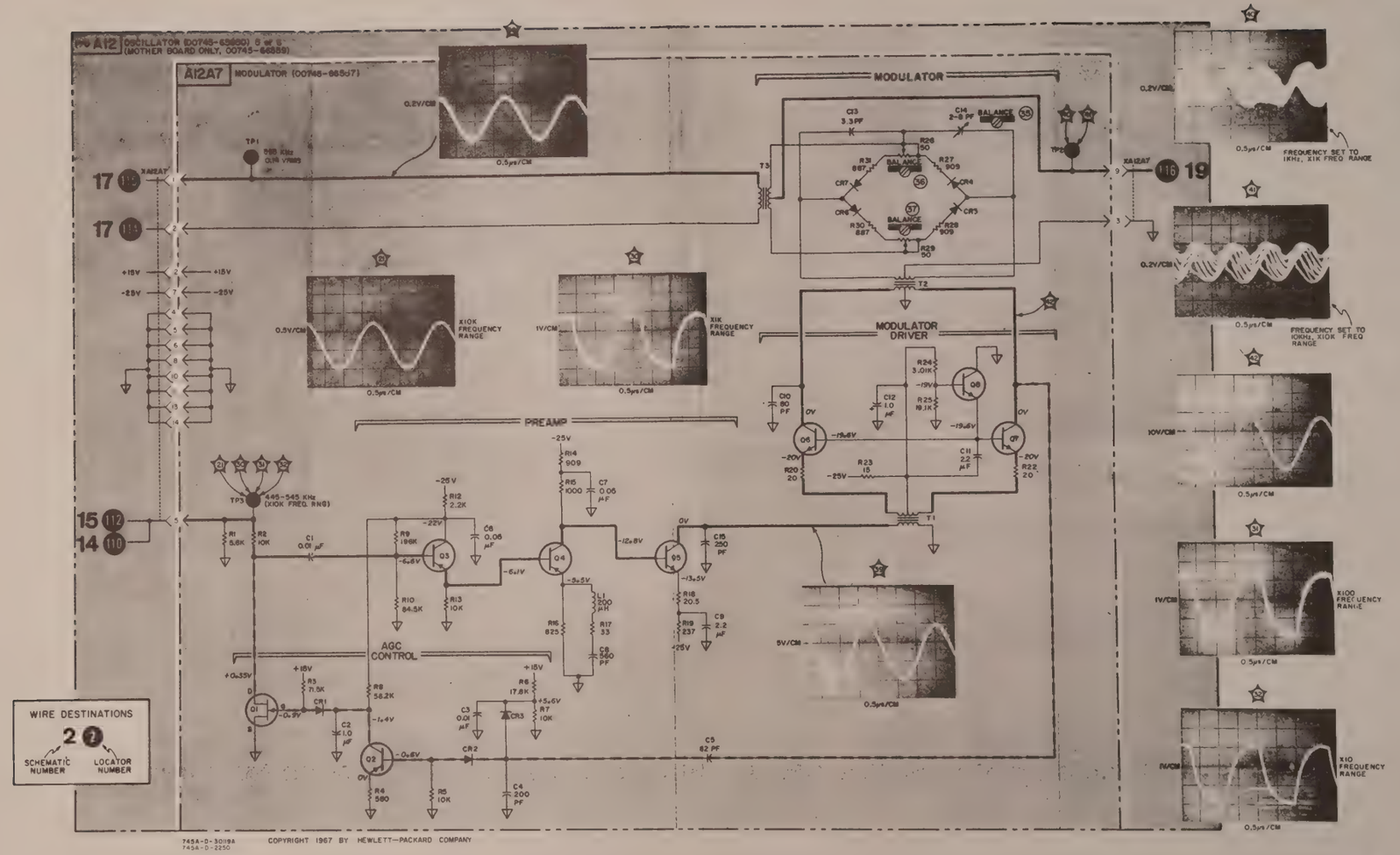
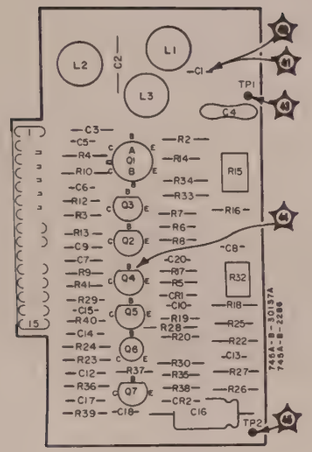


Figure 7-22. Modulator (A12A7) Schematic and Component Location Diagram



A12A8

hp Part No. 00745-66558

Rev D

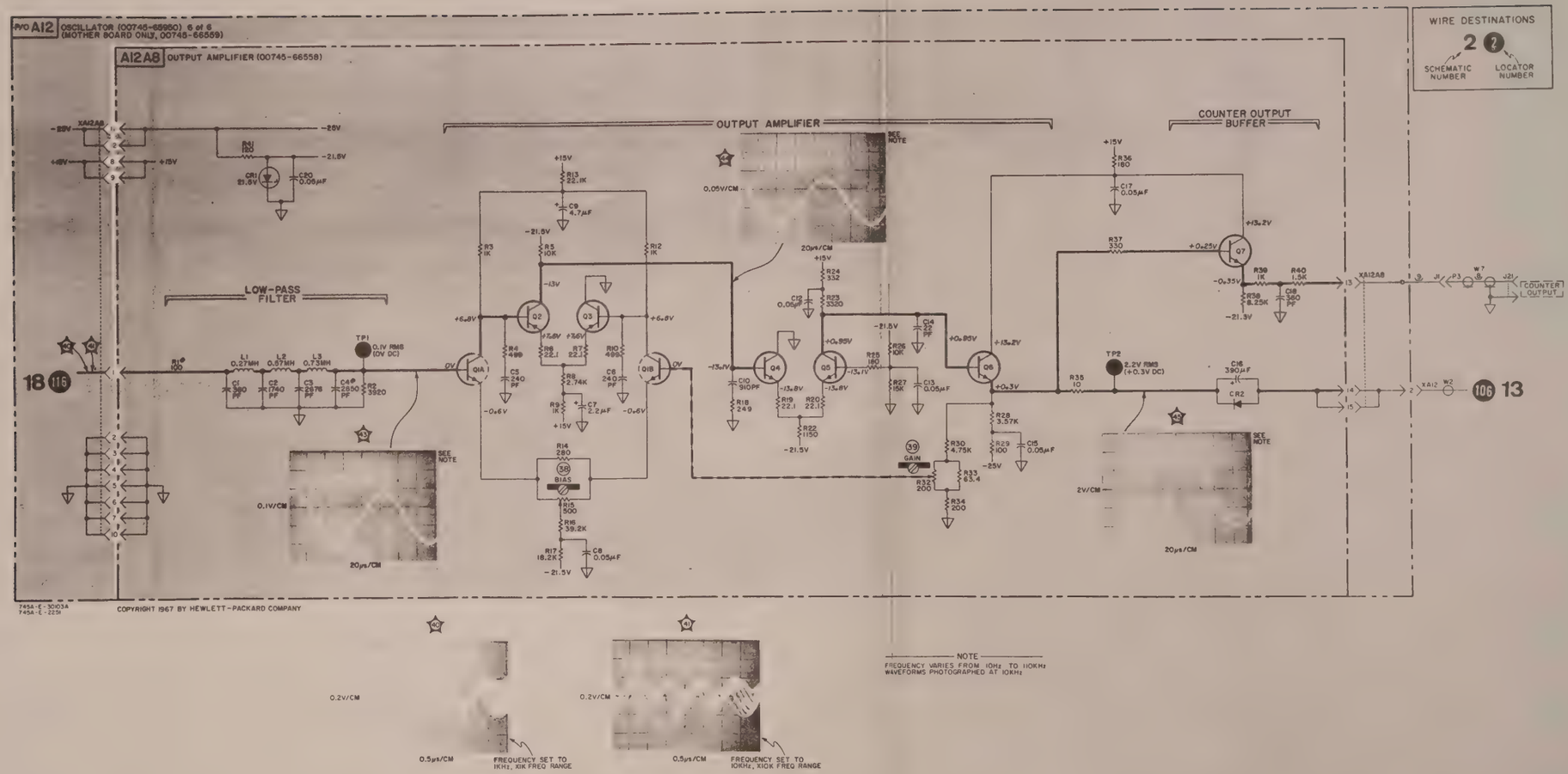
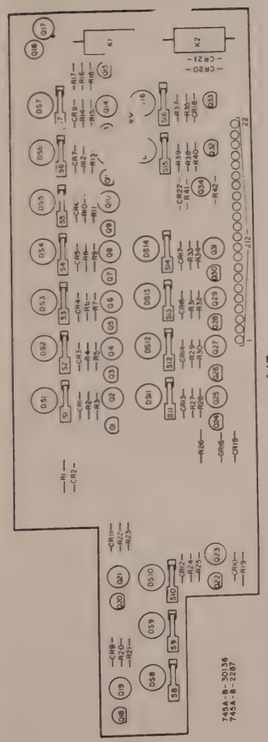
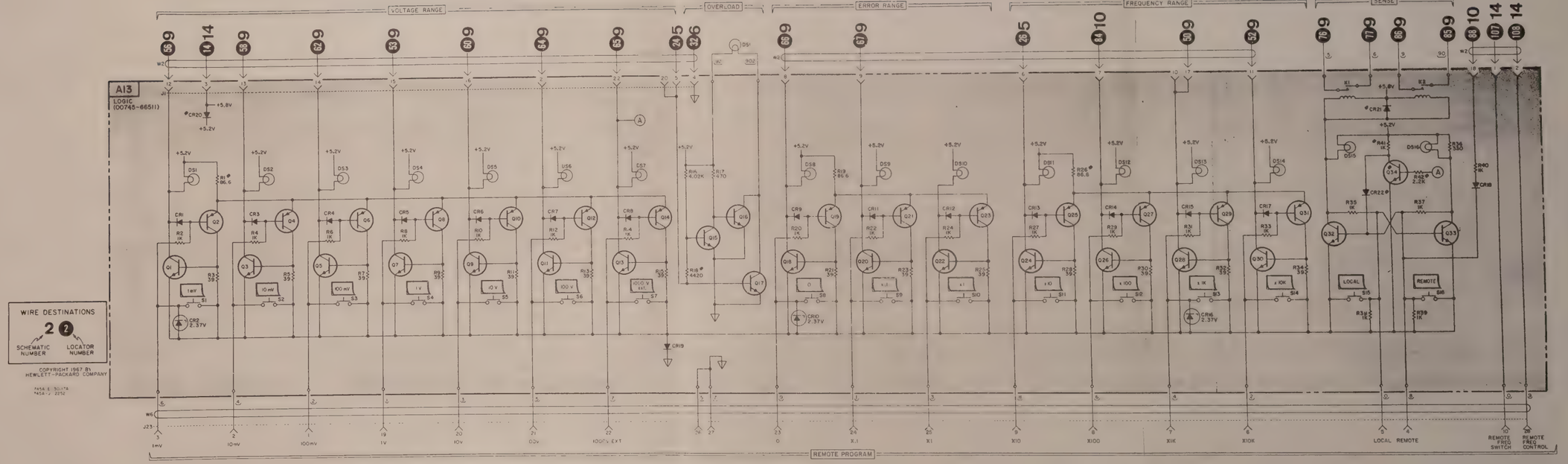


Figure 7-23. Output Amplifier (A12A8) Schematic and Component Location Diagram



A13
hp Part No. 00745-66511
Rev F

7454-B-30136
7454-B-2287



20

Figure 7-24. Front Panel Switching Logic (A13) Schematic and Component Location Diagram

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Cal.
85474	R.M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86176	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Specialty Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Stemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paseo Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron.	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

SUPPLEMENTAL CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
08261	Spectra-Strip Corp.	Garden Grove, Calif.
08806	General Electric Co., Miniature Lamp Dep't	Cleveland, Ohio
22753	UID Electronics Corp.	Hollywood, Fla.
24931	Specialty Connector Co. Inc.	Indianapolis, Ind.
28425	Bohannon Industries	Fort Worth, Tex.
28499	Chemelec Products Inc.	Cherry Hill, N.J.
83616	The Polymer Corp.	Reading, Pa.
90201	Mallory Capacitor Co.	Indianapolis, Ind.

00015-48
Revised: May, 1970

From: Handbook Supplements H4-1 Dated January 1970

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	H P Co. Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77945	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78453	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80415	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions given in TM 38-750.

b. Reporting of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 as prescribed in AR 700-58.

c. Discrepancey in Shipment Report. Fill out and forward Discrepancy in Shipment Record as prescribed in AR 55-38.

d. Reporting of Equipment Manual Improvements. Reporting of errors, omissions, and recommendations for improving this manual is encouraged. Submit all reccommendations for improvement on DA Form 2028 (Recommended Changes to Publications) to Commanding General, U.S. Army Missile Command, ATTN: AMSMI-MFM, Redstone Arsenal, Ala. 35809.

MANUAL BACKDATING CHANGES

Model 745A

AC CALIBRATOR

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial No.	Make Manual Changes
741-0085 and below	1 thru 6
741-00260 and below	2 thru 6
741-00310 and below	3 thru 6
905-00330 and below	4 thru 6
912-00370 and below	5 thru 6
912-00410 and below	6

Instrument Serial No.	Make Manual Changes

CHANGE NO. 1

Table 6-1 and Schematic No. 7: Delete A4CR3 and A4CR4.
Table 6-1 and Schematic No. 11: Delete A8CR25.
Table 6-1 and Schematic No. 13: Delete CR5.

NOTE

Components deleted in this change have been added to 745A Serial Number 741-00186 and greater to improve instrument performance. Refer to -hp- Service Note 745A-1 for complete modification instructions. Service notes can be obtained by contacting the nearest -hp- Sales and Service Office.

CHANGE NO. 2

NOTE

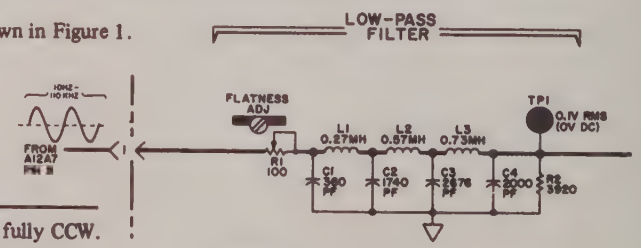
The following A12A8 changes apply only to instruments with 00745-66558 (A12A8) Revision A, B or C. Instruments with Model 746A compatability modification are equipped with 00745-66558 Revision D.

Table 6-1:

Change A12A8L1 Part No. to 9100-1409.
Change A12A8L2 Part No. to 9100-1410.
Change A12A8L3 Part No. to 9100-1411.
Add A12A8R1, 2100-1755 R: var ww lin 100 Ω ± 10% 1/2 W.

Schematic No. 19:

Add A12A8R1 as shown in Figure 1.



NOTE

Leave A23A8R1 set fully CCW.

Figure 1.

CHANGE NO. 3

Table 6-1 and Schematic No. 6:

Delete A3CR11 and A3CR12.

CHANGE NO. 4

Table 6-1 and Schematic No. 15:

Change A12A2, A3, A4 R25 to 0684-8221, R: fxd comp 8200Ω ± 10% 1/4 W.

Table 6-1 and Schematic No. 20:

Delete A13CR20 (short across).

Change A13R1, R19 and R26 to 0698-4406, R: fxd met flm 115Ω ± 1% 1/8 W.

NOTE

Resistors A12A2, A3, A4 R25 must be changed to 0683-6225, R: fxd comp 6200Ω ± 10% 1/4 W if A13CR20 is added or if A13 is replaced.

Table 6-1 and Schematic No. 13:

Serial Numbers 741-0286 through 905-0330 only:

Change A14C2 to 0160-0952, C: fxd mica 220 pF ± 1%.

Table 6-1 and Schematic No. 19:

Change A12A8C4 to 0140-0213, C: fxd mica 2000 pF ± 1%.

NOTE

For Serial Numbers 741-0286 through 905-0330, A12A8C4 should be changed to 2000 pF (-hp- Part No. 0140-0213) if Output Amplifier Assembly (A12A8) is replaced.

CHANGE NO. 5

Table 6-1 and Schematic No. 9:

Delete A6CR4 through A6CR12.

Table 6-1 and Schematic No. 10:

Delete A7CR1 through A7CR7.

745A/746A COMPATABILTIY MODIFICATIONS

NOTE

Compatability modifications will be performed under warranty on any Model 745A to be used with Model 746A.

a. The 1000 VOLT AMPL. connector (J20 - - Figure 7-1 and Schematic No. 12) is wired as shown in Figure 2 unless 745A/746A compatability modifications have been performed.

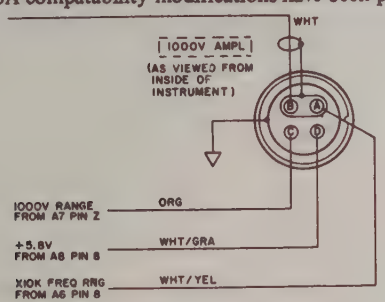


Figure 2.

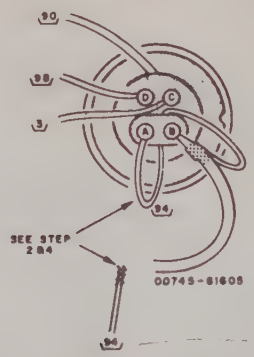
b. Compatability modifications for instruments with Serial Number 741-00260 and below require replacement of the Output Amplifier Assembly (A12A8) and relocation of a ground wire on Mother Board A14. A modification kit (-hp- Part No. 00745-84402) containing all necessary parts and instructions can be obtained (free-of-charge) from the nearest -hp- Sales and Service Office.

c. Instruments with Serial Numbers 741-00261 through 912-00370 require a simple wiring change on the 1000 VOLT AMPL. connector (J20). To perform this wiring change, proceed as follows:

1. Remove bottom covers.

2. Cut the WHT/YEL wire connected to J20 pin A approximately 1-1/2 inch away from pin A.

3. Connect the free end of the 1-1/2 inch wire to the shield that surrounds pins A and B as shown in Figure 3.



1000 VOLT AMPL CONNECTOR (J20)
(VIEWED FROM INSIDE INSTRUMENT)

Figure 3.

4. Tape the remainder of the WHT/YEL wire to prevent contact with the chassis and fold it into a corner. This completes the wiring modification.

CHANGE NO. 6

Table 6-1 and Schematic No. 20:

Delete A13CR21, A13CR22, A13R41, A13R42 and A13Q34.

NOTE

Components deleted in this change have been added to instruments with Serial Number 912-00411 and greater to automatically select LOCAL SENSE when the 1000 V EXT. VOLTAGE RANGE is selected. Instruments with Serial Number 912-00410 and below can be modified to select LOCAL SENSE when Model 746A OUTPUT ON is selected by connecting a wire between pin 7 of the 746A REMOTE PROGRAM connector and pin 5 of the 745A REMOTE PROGRAM CONNECTOR.

MAINTENANCE ALLOCATION CHART

FOR STANDARD, AC VOLTAGE, H-P 745A

CHART NUMBER MIS-10342

MAC PAGE

GROUP NUMBER	FUNCTIONAL GROUP	MAINTENANCE FUNCTIONS													
		a INSPECT	b TEST	c SERVICE	d ADJUST	e ALIGN	f CALIBRATE	g INSTALL	h REPLACE	i REPAIR	j OVERHAUL	k REBUILD	l TOOL REQD	m REMARKS
1	Standard, AC Voltage	H	H	F			H			H	H		1	A
2	A1 Assembly: Reference Square Wave Generator	H								H			2	B
3	A2 Assembly: Error Amplifier	H								H			2	B
4	A3 Assembly: Sampling Amplifier	H								H			2	B
5	A4 Assembly: Preamplifier	H								H			2	B
6	A5 Assembly: Power Amplifier	H								H			2	B
7	A6 Assembly: High Frequency Switching	H								H			2	B
8	A8 Assembly: Regulator	H								H			2	B
9	A9 Assembly: Rectifier	H								H			2	B
10	A10 Assembly: Decade	H								H			2	B
11	A12 Assembly: Oscillator	H								H			2	B
12	A13 Assembly: Logic	H								H			2	B
13	A7 Assembly: Low Frequency Switching	H								H			2	B

MAINTENANCE ALLOCATION CHART

FOR STANDARD, AC VOLTAGE, HpP 745A

CHART NUMBER MIS-10342

REMARKS PAGE

REMARKS CODE	REMARKS
A-b	Test in accordance with Section V.
A-c	Clean components and case periodically
A-f	Calibrate in accordance with Section VI.
A-i	Solder all connections per MIL-S-45743
A-j	Solder all connections per MIL-S-45743
B-i	Solder all connections per MIL-S-45743

MAINTENANCE ALLOCATION CHART

FOR STANDARD, AC VOLTAGE, H-P 745A

CHART NUMBER MIS-10342

TOOLS REQUIRED PAGE

TOOL CODE	CATEGORY	NOMENCLATURE	TOOL NUMBER
1-b	H	Measurement System, Frequency/Time	4931-921-7396
	H	Analyzer, Spectrum	4931-987-9002
	H	Measurement System, AC/DC Voltage	4931-113-0800
	H	Voltmeter, Electronic Thermo AC-DC	4931-917-9833
	H	Transformer, Variable Power	6120-168-3705
	H	Ratio Standard, AC	4931-777-9519
	H	Voltmeter, Electronic	6625-538-7079
	H	Voltage Standard	4931-913-3062
	H	Voltmeter, Digital	4931-932-5034
	H	Voltmeter, Electronic	6625-557-8261
	H	Graphical Display System	4931-951-6291
	H	Resistor, Standard Carbon	
	H	Cable Assembly, RF	4931-846-0010
	H	Cable Assembly, RF	4931-071-5375
	H	Cable Assembly, RF	4931-843-2792
	H	Cable Assembly, RF	4931-739-4412
1-c	F	Cloth, Lint Free	7920-205-3571
	F	Brush, Dusting	7920-685-3480
	F	Brush, Artists	2020-262-9099
1-f	H	Measurement System, Frequency/Time	4931-921-7396
	H	Analyzer, Spectrum	4931-987-9002
	H	Measurement System, AC/DC Voltage Differential	4931-113-0800
	H	Voltmeter, Electronic Thermo, AC-DC	4931-917-9833
	H	Transformer, Variable Power	6120-168-3705
	H	Voltmeter, Digital	4931-932-5034
	H	Voltmeter, Electronic	6625-557-8261
	H	Graphical Display System	4931-951-6291
	H	Cable Assembly, RF	4931-846-0010
	H	Cable Assembly, RF	4931-071-5375
	H	Cable Assembly, RF	4931-843-2792
	H	Cable Assembly, RF	4931-739-4412
	H	Tool Kit, Calibration Technician	4935-670-7123
	H	Voltmeter	6625-538-7079

MAINTENANCE ALLOCATION CHART

FOR STANDARD, AC VOLTAGE, M-P 745A

CHART NUMBER MIS-10362

TOOLS REQUIRED PAGE

TOOL CODE	CATEGORY	NOMENCLATURE	TOOL NUMBER
1i	H	Multimeter	6625-902-7140
	H	Graphical Display System	4931-981-6291
	H	Measurement System, Frequency/Time	4931-921-7396
	H	Tool Kit, Calibration Technician	4935-670-7123
1j	H	Multimeter	6625-902-7140
	H	Graphical Display System	4931-951-6291
	H	Measurement System Frequency/Time	4931-921-7396
	H	Tool Kit, Calibration Technician	4935-670-7123
2i	H	Multimeter	6625-902-7140
	H	Graphical Display System	4931-951-6291
	H	Tool Kit, Calibration Technician	4935-670-7123

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